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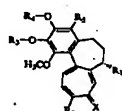
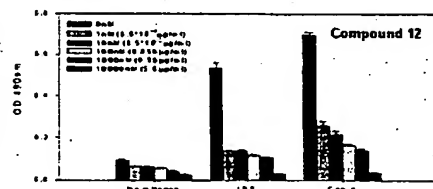
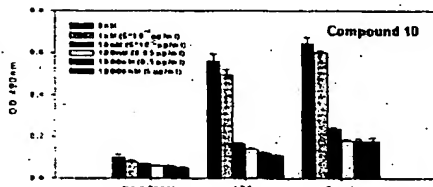
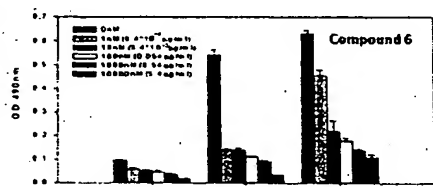
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[Continued on next page]

- (54) Title:** A NOVEL ALKALOID DERIVATIVE AND A PHARMACEUTICAL COMPOSITION CONTAINING THE SAME



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- (57) Abstract:** The present invention is to provide a novel colchicine derivative represented by the formula (I) with halogen or nitric ester group, or pharmaceutically acceptable salts thereof, pharmaceutical compositions containing the same as effective components and having anticancer, anti-proliferous and immunosuppressive functions, and methods for preparing the colchicine derivatives:

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A NOVEL ALKALOID DERIVATIVE AND A PHARMACEUTICAL COMPOSITION CONTAINING THE SAME

Technical Field

5 The present invention relates to a novel alkaloid derivative and a pharmaceutical composition containing the same. More particularly, the present invention relates to a novel colchicine derivative having anticancer, anti-proliferous and anti-inflammatory effects and immunosuppressive and muscle relaxing functions, and pharmaceutically acceptable salts thereof, a pharmaceutical composition
10 containing the same as an effective component, and methods for preparing the same.

Background Art

 Colchicine is a pseudo-alkaloid widely used for treatment of gout and is used only for short-term therapeutic treatment due to its toxicity. However, colchicine
15 has been reported to exhibit a very fast and specific therapeutic effect on gout, as described in the Alkaloids, 1991, vol. 41, 125-176, U.S. patent No. 4,533,675, and so on.

 During cell division, colchicine inhibits formation of mitotic spindle, thereby suppresses cell division, leading to activation of anticancer and anti-proliferous
20 effects. Also, continuous research into colchicine applications has been carried out and a variety of colchicine derivatives have been synthesized up to now, as described in U.S. patent No. 3,222,253, U.S. patent application serial No. 00/608073A, WO 91/02084, and so on. Among them, only demecolcine has been used for treatment of leukemia.

25 There is also a report that colchicine can be used for treatment of psoriasis or rheumatoid arthritis and has an amyloidosis inhibitory effect and an anti-inflammatory effect (*Arch. Dermatol.* 1982, Vol. 118, July, pp 453-457). Also, thiocolchicoside, which is one of colchicine derivatives, is widely used for treatment of skeletal muscle contracture and inflammation.

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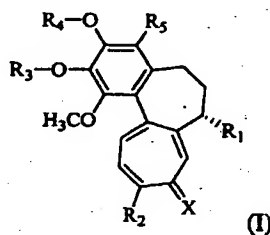
Disclosure of the Invention

A first feature of the present invention is to provide a novel colchicine derivative having anticancer, anti-proliferous and anti-inflammatory effects and immunosuppressive and muscle-relaxing functions, and pharmaceutically acceptable salts thereof.

A second feature of the present invention is to provide methods for preparing the colchicine derivatives.

A third feature of the present invention is to provide a pharmaceutical composition containing the colchicine derivative and pharmaceutically acceptable salts thereof as an effective component.

In an aspect of the present invention, it is provided colchicine derivatives represented by the formula (I) and pharmaceutically acceptable salts thereof:



wherein

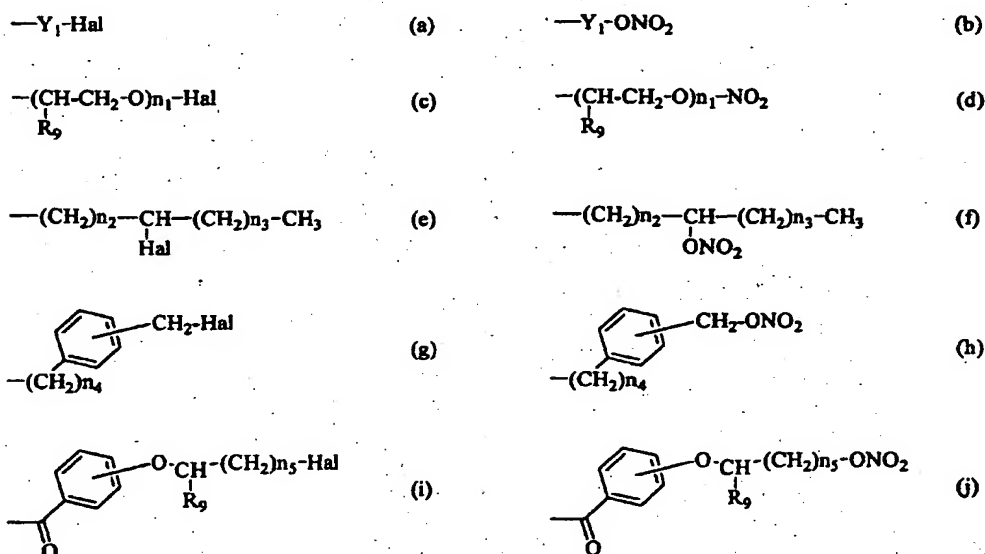
when R_1 is $N(R_6)C(X_1)-A$, $X_2C(X_1)-A$, $N(R_6)-A$, $N(A)_2$ or X_2-A , R_2 is X_3R_7 or $N(R_7)_2$, R_3 and R_4 are independently hydrogen or a methyl group, R_5 is hydrogen, a methyl group or $CH_2X_4R_7$, wherein R_6 and R_7 are independently hydrogen or a lower alkyl, and X , X_1 , X_2 , X_3 and X_4 are independently O or S;

when R_2 is $N(R_6)C(X_1)-A$, $X_2C(X_1)-A$, $N(R_6)-A$, $N(A)_2$ or X_2-A , R_1 is $N(R_6)COCH_3$, $N(R_6)COCF_3$, or $NHC(O)OR_8$, R_3 and R_4 are independently hydrogen or a methyl group, R_5 is hydrogen, a methyl group or $CH_2X_4R_7$, wherein R_6 and R_7 are independently hydrogen or a lower alkyl, R_8 is a lower alkyl, alkenyl, or substituted or unsubstituted aryl, and X , X_1 , X_2 and X_4 are independently O or S;

when R_3 and R_4 are independently $C(X_1)-A$ or $-A$, R_1 is $N(R_6)COCH_3$, $N(R_6)COCF_3$, or $NHC(O)OR_8$, R_2 is X_3R_7 or $N(R_7)_2$, R_5 is hydrogen, a methyl or $CH_2X_4R_7$, wherein R_6 and R_7 are independently hydrogen or a lower alkyl, R_8 is a

lower alkyl, alkenyl, or substituted or unsubstituted aryl, and X, X₁, X₃ or X₄ are independently O or S;

when R₅ is CH₂X₂C(X₁)-A, R₁ is N(R₆)COCH₃, N(R₆)COCF₃ or NHC(O)OR₈, R₂ is X₃R₇ or N(R₇)₂, R₃ and R₄ are independently hydrogen or a methyl group, wherein R₆ and R₇ are independently hydrogen or a lower alkyl, R₈ is a lower alkyl, alkenyl, or substituted or unsubstituted aryl, and X, X₁, X₂ and X₃ are independently O or S, wherein A is represented by the formula (a), (b), (c), (d), (e), (f), (g), (h), (i) or (j):



10

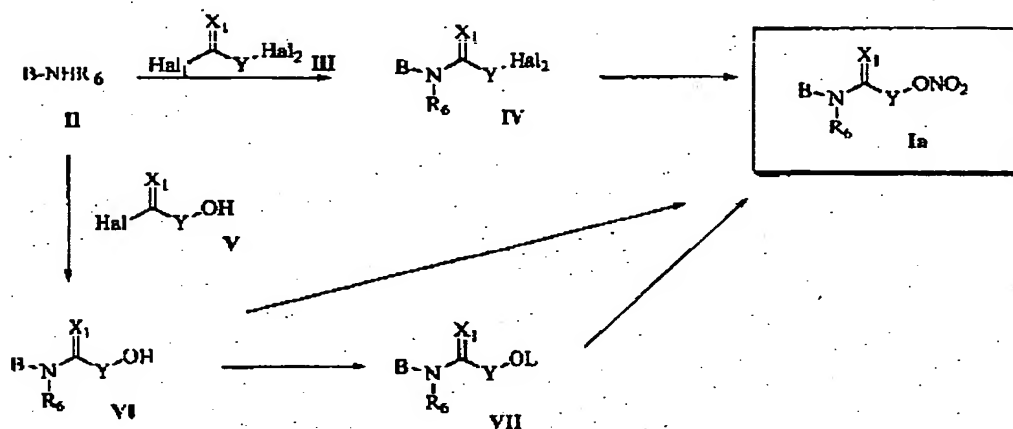
wherein Y₁ is a C₁ to C₁₀ straight chain or branched alkyl, preferably, a C₂ to C₅ straight chain or branched alkyl or a substituted C₅ to C₇ cycloalkyl; Hal is halogen, for example, F, Cl, Br or I, R₉ is hydrogen or a lower alkyl; n₁ is an integer from 1 to 6, preferably from 2 to 4; n₂ and n₃ are independently an integer from 1 to 5, preferably from 1 to 3; n₄ is an integer from 0 to 3; and n₅ is an integer from 1 to 6.

In another aspect of the present invention, it is provided a pharmaceutical composition containing the colchicine derivatives and pharmaceutically acceptable salts thereof as effective components, the pharmaceutical composition having anticancer, anti-proliferous and anti-inflammatory effects and immunosuppressive and muscle-relaxing functions.

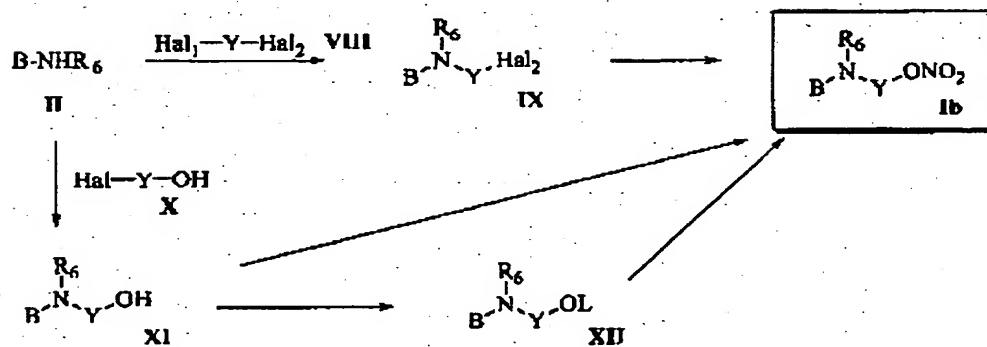
20

In still another aspect of the present invention, it is provided methods for preparing the colchicine derivative represented by the formula (I) according to the reaction schemes 1, 2, 3, 4 and 5. In the reaction schemes 1 to 5, the colchicine derivatives of the formula (I) are represented as the formula (Ia), (Ib), (Ic), (Id), or (Ie):

Reaction scheme 1 (Method 1)

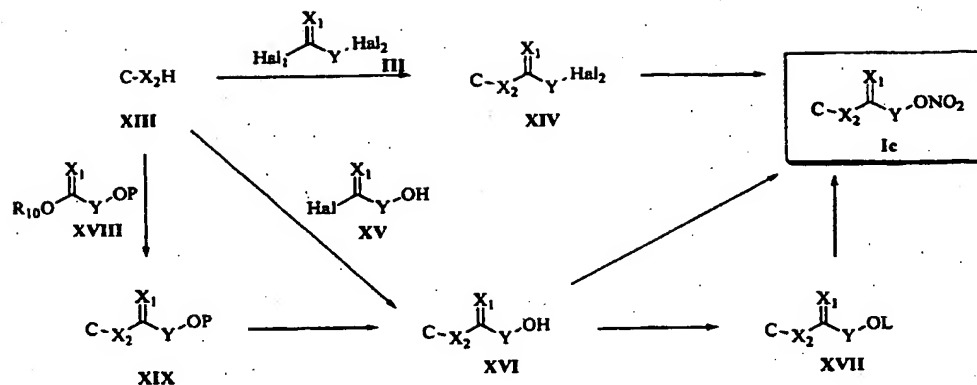


10 Reaction scheme 2 (Method 2)

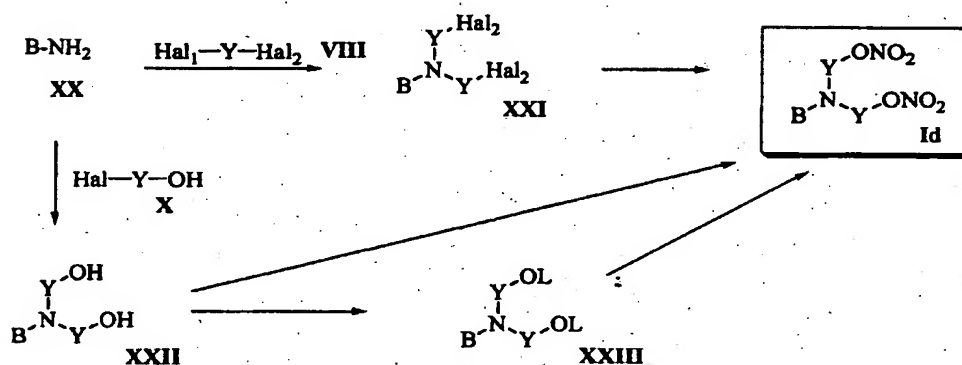


Reaction scheme 3 (Method 3)

5

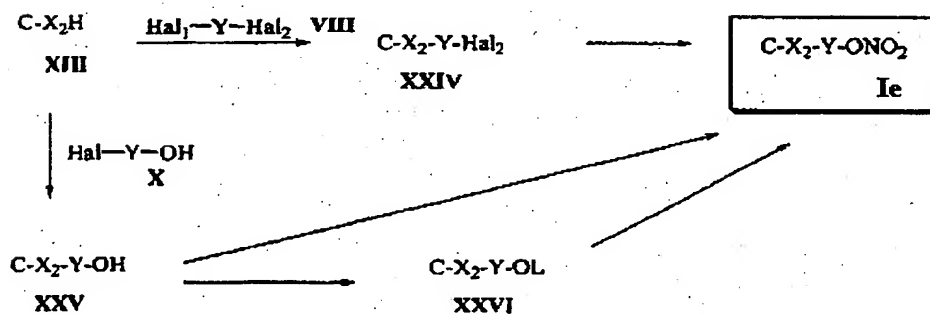


Reaction scheme 4 (Method 4)



5

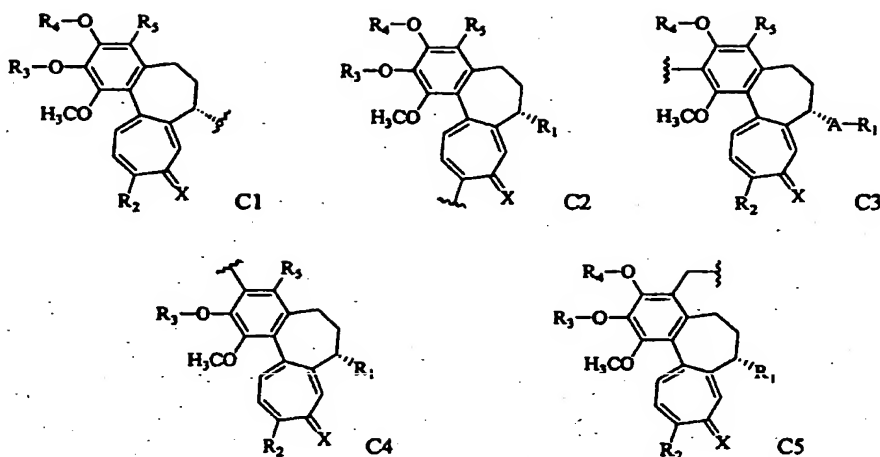
Reaction scheme 5 (Method 5)



wherein B in the formulas (Ia), (Ib), (Ic), (Id) and (Ie) is represented by the formula C1 or C2, and C in the formulas is represented by the formula C1, C2, C3,

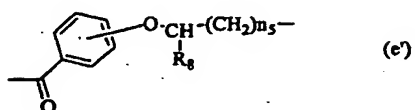
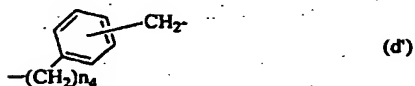
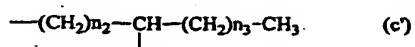
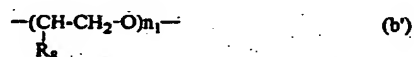
10 C4 or C5:

6



wherein R_1 through R_5 and X are defined as in the compound of the formula (I).

- 5 R_6 is hydrogen or a lower alkyl; X_1 and X_2 are independently O or S; Hal, Hal₁, and Hal₂ may be the same or different halogens; L is a leaving group selected from methanesulfonyl, *p*-toluenesulfonyl or triflate; P represents a general hydroxy-protecting group including methoxymethyl or *t*-butyldimethylsilyl; R_{10} is hydrogen or a lower alcohol of C_1 to C_3 ; and Y is represented by the general formula (a'), (b'), (c'), (d') or (e'):



10

wherein Y_1 represents a C_1 to C_{10} straight chain or branched alkyl, preferably, a C_2 to C_5 straight chain or branched alkyl, or a substituted C_5 to C_7 cycloalkyl, R_8

represents hydrogen or a lower alkyl, n_1 is an integer from 1 to 6, preferably an integer from 2 to 4, n_2 and n_3 are independently an integer from 1 to 5, preferably an integer from 1 to 3, n_4 is an integer 0 to 3, and n_5 is an integer from 1 to 6.

5 Brief Description of the Drawings

FIG. 1 is a graph showing the immunosuppressive effect of a colchicine derivative tested by mixed lymphocyte reaction (MLR);

FIG. 2 is a graph showing the immunosuppressive effect of cyclosporine A as a positive control sample in an immunosuppressive effect test using a BALB/c
10 mouse spleen; and

FIG. 3 is a graph showing the immunosuppressive effect of a colchicine derivative according to the present invention in an immunosuppressive effect test using a BALB/c mouse spleen.

15 Best mode for carrying out the Invention

The present invention will now be described in more detail.

Throughout the specification, a lower alkyl represents a saturated C_1 to C_6 , preferably, C_1 to C_4 straight chain or branched hydrocarbon.

Preferred examples of the colchicine derivative of the formula (I) and its
20 pharmaceutically acceptable salt according to the present invention include:

4-chloro-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide;

4-chloromethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;

25 3-chloromethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;

4-iodo-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide;

4-nitrooxy-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide;
30

4-iodomethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-

- 7-yl)-benzamide;
4-nitrooxymethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-
benzo[a]heptarene-7-yl)-benzamide;
3-iodomethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-
5 7-yl)-benzamide;
3-nitrooxymethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-
benzo[a]heptarene-7-yl)-benzamide;
4-chloro-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-
benzo[a]heptarene-7-yl)-butylamide;
10 4-chloromethyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-
benzo[a]heptarene-7-yl)-benzamide;
3-chloromethyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-
benzo[a]heptarene-7-yl)-benzamide;
4-iodo-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-
15 benzo[a]heptarene-7-yl)-butylamide;
4-nitrooxy-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-
benzo[a]heptarene-7-yl)-butylamide;
4-iodomethyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-
benzo[a]heptarene-7-yl)-benzamide;
20 4-nitrooxymethyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-
benzo[a]heptarene-7-yl)-benzamide;
3-iodomethyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-
benzo[a]heptarene-7-yl)-benzamide;
3-nitrooxymethyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-
25 benzo[a]heptarene-7-yl)-benzamide;
N-(7-acetylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-10-
yl)-4-chloromethyl-benzamide;
N-(7-acetylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-10-
yl)-4-iodomethyl-benzamide;
30 N-(7-acetylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-10-
yl)-4-nitrooxymethyl-benzamide;

- 4-chloromethyl-benzoic acid 7-acetylamino-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl-methyl ester;
- 4-chloromethyl-benzoic acid 7-acetylamino-1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl-methyl ester;
- 5 4-chloro-butyric acid 7-acetylamino-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl-methyl ester;
- 4-chloro-butyric acid 7-acetylamino-1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl-methyl ester;
- 4-nitrooxymethyl-benzoic acid 7-acetylamino-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl-methyl ester;
- 10 4-iodomethyl-butyric acid 7-acetylamino-1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl-methyl ester;
- 4-nitrooxymethyl-butyric acid 7-acetylamino-1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl-methyl ester;
- 15 4-iodomethyl-benzoic acid 7-acetylamino-1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl-methyl ester;
- 4-nitrooxymethyl-benzoic acid 7-acetylamino-1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl-methyl ester;
- (-)-3-chloromethyl-benzoic acid 1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
- 20 (+)-3-chloromethyl-benzoic acid 1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
- (-)-3-iodomethyl-benzoic acid 1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
- 25 (+)-3-iodomethyl-benzoic acid 1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
- (-)-3-nitrooxymethyl-benzoic acid 1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
- (+)-3-nitrooxymethyl-benzoic acid 1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
- 30 4-chloro-butyric acid 7-acetylamino-1,2,10-trimethoxy-9-oxo-5,6,7,9-tetrahydro-

- benzo[a]heptarene-3-yl ester;
4-chloromethyl-benzoic acid 7-acetylamino-1,2,10-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-3-yl ester;
3-chloromethyl-benzoic acid 7-acetylamino-1,2,10-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-3-yl ester;
5 4-nitrooxy-butylric acid 7-acetylamino-1,2,10-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-3-yl ester;
4-nitrooxymethyl-benzoic acid 7-acetylamino-1,2,10-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-3-yl ester;
10 3-nitrooxymethyl-benzoic acid 7-acetylamino-1,2,10-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-3-yl ester;
4-chloro-N-methyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide;
4-nitrooxymethyl-N-methyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
15 3-nitrooxymethyl-N-methyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
(-)-3-chloromethyl-benzoic acid 1,2,3-trimethoxy-10-methylsulfenyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
20 (+)-3-chloromethyl-benzoic acid 1,2,3-trimethoxy-10-methylsulfenyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
(-)-3-nitrooxymethyl-benzoic acid 1,2,3-trimethoxy-10-methylsulfenyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
(+)-3-nitrooxymethyl-benzoic acid 1,2,3-trimethoxy-10-methylsulfenyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
25 4-chloro-N-methyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl) butylamide;
4-chloromethyl-N-methyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl) benzamide;
30 N-methyl-4-nitrooxy-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl) butylamide;

- N-methyl-4-nitrooxymethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl) benzamide;
- 4-nitrooxy-butyric acid 7-acetylamino-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl methyl ester;
- 5 4-chloro-N-(1,2,3-trimethoxy-4-methoxymethyl-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide;
- 4-chloromethyl-N-(1,2,3-trimethoxy-4-methoxymethyl-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- 4-nitrooxy-N-(1,2,3-trimethoxy-4-methoxymethyl-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide;
- 10 4-nitrooxymethyl-N-(1,2,3-trimethoxy-4-methoxymethyl-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- N-(7-acetylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-10-yl)-3-chloromethyl-benzamide;
- 15 N-(7-acetylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-10-yl)-3-nitrooxymethyl-benzamide;
- N-(7-acetylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-10-yl)-4-chloro-butylamide;
- 4-chloromethyl-N-(10-dimethylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- 20 N-(10-dimethylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-4-nitrooxymethyl-benzamide;
- 3-chloromethyl-N-(10-dimethylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- 25 N-(10-dimethylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-3-nitrooxymethyl-benzamide;
- 4-chloro-N-(10-dimethylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butyramide; and
- N-(10-dimethylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-4-nitrooxy-butyramide.
- 30

Examples of the pharmaceutically acceptable salt of the colchicine derivative of the formula (I) include, but are not limited to, salts with inorganic bases such as sodium, potassium, magnesium or calcium and salts with organic bases such as ammonium, lysine, ethanolamine, N,N'-dibenzylethylenediamine and angelic acid

5 Preparation methods of the invention will now be described in more detail.

Method 1

In Method 1 for preparing a compound of the formula (Ia), first, a compound of the formula (II) is reacted with a compound of the formula (III) to produce a compound (IV). The reaction can be carried out without using a base, but is
10 generally carried out in the presence of a base used for amidation. Preferred examples of the base include pyridine, triethylamine, diethylisopropylamine and dimethylphenylamine, and a phase transfer catalyst such as sodium hydrocarbonate or benzyltriethylammonium chloride. The reaction can be carried out without using a solvent, but is advantageously carried out in the presence of a solvent that does not
15 adversely affect the reaction. Examples of the solvent used include dichloromethane, chloroform, tetrahydrofuran, diethylether, toluene and dimethylformamide. The reaction temperature is not specifically limited and is generally carried out at reduced or elevated temperature, preferably at room temperature.

Second, the compound of the formula (IV) is subjected to nitration to convert
20 it into a compound of the formula (Ia). Compounds capable of nitrating halogen are generally used for the reaction, and examples of such compounds include AgNO_3 and t-butylammonium nitrate (Bu_4NNO_3). The reaction is preferably carried out in the presence of a solvent that does not adversely affect the reaction, and examples of such solvent include chloroform, acetonitrile, a mixed solution of acetonitrile and water,
25 dichloromethane, and the like. The reaction temperature is not specifically limited and is generally carried out at reduced or elevated temperature, preferably at room temperature.

Alternatively, the compound of the formula (Ia) can be synthesized by reacting the compound of the formula (II) with a compound of the formula (V) to produce a
30 compound (VI), followed by converting it into the compound (Ia). The conditions for reacting the compound of the formula (II) with the compound of the formula (V)

are the same as those for amidation like in the reaction between the compound of the formula (II) and the compound of the formula (III). In order to convert the compound (VI) into the compound of the formula (Ia), the reaction is generally carried out under nitrating conditions of alcohol. Preferably, nitric acid and sulfuric acid, dinitrogen pentaoxide (N_2O_5) and aluminum chloride III, potassium nitrate and boron trifluoride (BF_3), acetylnitrate, etc., may be used, most preferably nitric acid and acetic anhydride (Ac_2O) are used. The reaction is preferably carried out in the presence of a solvent that does not adversely affect the reaction, and examples of the solvent used include chloroform, dichloromethane, and the like. The reaction temperature is not specifically limited and is generally carried out at reduced or elevated temperature, preferably at room temperature.

The compound of the formula (Ia) can also be synthesized by performing nitration a compound of the formula (VII) prepared by converting hydrogen of alcohol in the compound of the formula (VI) into a leaving group such as methane sulfonyl, *p*-toluene sulfonyl or triflate. In order to convert the compound (VII) into the compound of the formula (Ia), the reaction is generally carried out under nitrating conditions. Most preferably, *t*-butylammonium nitrate (Bu_4NNO_3), *t*-butylammonium nitrate (Bu_4NNO_3) and nitric acid, nitric acid and silver nitrate, or potassium nitrate is used. The reaction is preferably carried out in the presence of a solvent that does not adversely affect the reaction. Examples of the solvent used include chloroform, dichloromethane, a mixed solution of benzene and water, acetonitrile, ethylalcohol, and the like. The reaction temperature is not specifically limited and is generally carried out at reduced or elevated temperature, preferably at room temperature.

Desired products can be isolated and purified by general methods, for example, column chromatography or recrystallization.

Method 2

In Method 2 for preparing a compound of the formula (Ib), first, a compound of the formula (II) is reacted with a compound of the formula (VIII) to produce a compound (IX). The reaction is generally carried out in the same manner as in the amidation for converting the compound (II) into the compound (IV) as described in

Method 1.

Second, the compound of the formula (IX) is subjected to nitration to produce the compound of the formula (Ib). This reaction is generally carried out in the same manner as in the nitration for converting the compound of the formula (IV) into the compound of the formula (Ia) as described in Method 1.

Alternatively, the compound of the formula (Ib) can be synthesized by reacting the compound of the formula (II) with a compound of the formula (X) to produce a compound (XI), followed by converting the same into the compound (Ib). The conditions of reacting the compound of the formula (II) with the compound of the formula (X) are the same as those for amidation like in the reaction between the compound of the formula (II) and the compound of the formula (IV) as described in Method 1. In order to convert the compound (XI) into the compound of the formula (Ib), the reaction is generally carried out under nitrating conditions of an alcoholic compound, that is, under the same conditions as those of converting the compound of the formula (VI) into the compound of the formula (Ia) as described in Method 1.

The compound of the formula (Ib) can also be synthesized by performing nitration the compound of the formula (XII) prepared by converting hydrogen of alcohol in the compound of the formula (XI) into a leaving group such as methane sulfonyl, *p*-toluene sulfonyl or triflate. In order to convert the compound (XII) into the compound of the formula (Ib), the reaction is generally carried out under nitrating conditions, that is, under the same conditions of converting the compound of the formula (VII) into the compound of the formula (Ia) as described in Method 1.

Desired products can be isolated and purified by general methods, for example, column chromatography or recrystallization.

Method 3

In Method 3 for preparing a compound of the formula (Ic), first, a compound of the formula (III) is reacted with a compound of the formula (XIII) to produce a compound (XIV). The reaction is generally esterification between alcohol ($X_2=O$) or thioalcohol ($X_2=S$) and acyl or thioacyl halide, that is, the reaction is carried out in the presence of nickelacetylacetonate or zinc chloride or in the presence of a base that can be used for esterification. Examples of the base include pyridine,

4-dimethylaminopyridine, triethylamine, diethylisopropylamine, dimethylphenylamine, 2,6-lutidine, or sodium hydride (NaH), cesium carbonate, and a phase transfer catalyst such as sodium hydroxide or benzyltriethylammonium chloride.

Also, the reaction can be advantageously carried out in the presence of a solvent that
5 does not adversely affect the reaction. Examples of the solvent include dichloromethane, chloroform, tetrahydrofuran, diethylether, toluene, dimethylformamide, toluene, dimethylformamide, acetonitrile, and the like. The reaction temperature is not specifically limited and is generally carried out at reduced or elevated temperature, preferably at room temperature.

10 Second, the compound of the formula (XIV) synthesized in the first step is subjected to nitration to produce the compound of the formula (Ic). This reaction is generally carried out in the same manner as in the nitration of halogen for converting the compound of the formula (IV) into the compound of the formula (Ia) as described in Method 1.

15 Alternatively, the compound of the formula (Ic) can be synthesized by reacting the compound of the formula (XIII) with a compound of the formula (XV) to produce a compound (XVI), followed by converting the same into the compound (Ic). The reaction between the compound of the formula (XIII) and the compound of the formula (XV) is generally esterification between alcohol ($X_2=O$) or thioalcohol
20 ($X_2=S$) and acyl or thioacyl halide, that is, the reaction is carried out under the same conditions as the reaction between the compound of the formula (XIII) and the compound of the formula (III) as mentioned above. In order to convert the compound (XVI) into the compound of the formula (Ic), the reaction is generally carried out under nitrating conditions of an alcoholic compound, that is, under the
25 same conditions as those of converting the compound of the formula (VI) into the compound of the formula (Ia) as described in Method 1.

The compound of the formula (Ic) also can be synthesized by performing nitration the compound of the formula (XVII) prepared by converting hydrogen of alcohol in the compound (XVI) is converted into a leaving group such as methane
30 sulfonyl, *p*-toluene sulfonyl or triflate. In order to convert the compound (XVII) into the compound of the formula (Ic), the reaction is generally carried out under nitrating

conditions of an alcoholic compound, that is, under the same conditions of converting the compound of the formula (VII) into the compound of the formula (Ia) as described in Method 1.

Also, the compound of the formula (Ic) can be synthesized by reacting the compound of the formula (XIII) with a compound of the formula (XVIII) having a protecting group in alcohol to convert the same into a compound of the formula (XIX), followed by converting the compound of the formula (XIX) into the compound (XVI) by a deprotection. The conversion of the compound of the formula (XIII) into the compound of the formula (XIX) is generally esterification between alcohol ($X_2=O$) or thioalcohol ($X_2=S$) and carboxylic acid ($R_{10}=H$) or carboxylic acid ester (R_{10} =a lower alkyl of C_1 to C_3). When R_{10} is H, the reaction is preferably carried out in the presence of a base, preferably pentafluorophenyl and pyridine, or ethylchloroformate and triethylamine. This reaction can also be carried out without using a solvent, preferably in the presence of a solvent that does not adversely affect the reaction. Examples of the solvent include dichloromethane, chloroform, tetrahydrofuran, diethylether, and the like. The reaction temperature is not specifically limited and is generally carried out at reduced or elevated temperature, preferably at room temperature.

Desired products can be isolated and purified by general methods; for example, column chromatography or recrystallization.

Method 4

In Method 4 for preparing a compound of the formula (Id), first, a compound of the formula (XX) is reacted with a compound of the formula (VIII) to produce a compound (XXI). The reaction is generally carried out in the same manner as in the amidation for converting the compound (II) into the compound (IV) as described in Method 1.

Second, the compound of the formula (XXI) synthesized in the first step is subjected to nitration to produce the compound of the formula (Id). This reaction is generally carried out in the same manner as in the nitration of halogen for converting the compound of the formula (IV) into the compound of the formula (Ia) as described in Method 1.

Alternatively, the compound of the formula (Id) can be synthesized by reacting the compound of the formula (XX) with a compound of the formula (X) to produce a compound (XXII), followed by converting the same into the compound (Id). The conditions of reacting the compound of the formula (XX) with the compound of the formula (X) are the same as those for amidation by which the compound of the formula (II) is converted into the compound of the formula (IV) as described in Method 1. In order to convert the compound (XXII) into the compound of the formula (Id), the reaction is generally carried out under nitrating conditions of an alcoholic compound, that is, under the same conditions as those of converting the compound of the formula (VI) into the compound of the formula (Ia) as described in Method 1.

The compound of the formula (Id) can also be synthesized by performing nitration the compound of the formula (XXIII) prepared by converting hydrogen of alcohol in the compound of the formula (XXII) into a leaving group such as methane sulfonyl, *p*-toluene sulfonyl or triflate. In order to convert the compound (XXIII) into the compound of the formula (Id), the reaction is generally carried out under nitrating conditions, that is, under the same conditions of converting the compound of the formula (VII) into the compound of the formula (Ia) as described in Method 1.

Desired products can be isolated and purified by general methods, for example, column chromatography or recrystallization.

Method 5

In Method 5 for preparing a compound of the formula (Ie), first, a compound of the formula (XIII) is reacted with a compound of the formula (VIII) to produce a compound (XXIV). The reaction is generally a reaction between alcohol ($X_2=O$) or thioalcohol ($X_2=S$) and alkylhalide to produce ether or thioether, preferably in the presence of a base that can be used for etherification. Examples of the base include sodium hydride (NaH), cesium carbonate, silver carbonate, a phase transfer catalyst such as sodium or potassium hydroxide or benzyltriethylammonium chloride, or crown ether. The reaction is preferably carried out in the presence of a solvent that does not adversely affect the reaction. Examples of the solvent include dichloromethane, chloroform, tetrahydrofuran, diethylether, toluene,

dimethylformamide, dimethyl sulfoxide, or benzene. The reaction temperature is not specifically limited and is generally carried out at reduced or elevated temperature, preferably at cooling temperature or room temperature.

Second, the compound of the formula (XXIV) synthesized in the first step is
5 subjected to nitration to convert the same into a compound of the formula (Ie). The reaction is generally carried out in the same manner as in the nitration of halogen for converting the compound (IV) into the compound (Ia) as described in Method 1.

Alternatively, the compound of the formula (Ie) can be synthesized by reacting
the compound of the formula (XIII) with a compound of the formula (X) to produce a
10 compound (XXV), followed by converting the same into the compound (Ie). The conditions of reacting the compound of the formula (XIII) with the compound of the formula (X) are the same as those for the reaction between the compound of the formula (XIII) and the compound of the formula (VIII). In order to convert the compound (XXV) into the compound of the formula (Ie), the reaction is generally
15 carried out under nitrating conditions of an alcoholic compound, preferably under the same conditions for the reaction for converting the compound of the formula (VI) into the compound of the formula (Ia) as described in Method 1.

The compound of the formula (Ie) can also be synthesized by performing
nitration a compound of the formula (XXVI) prepared by converting hydrogen in
20 alcohol in the compound of the formula (XXV) into a leaving group such as methane sulfonyl, *p*-toluene sulfonyl or triflate. In order to convert the compound (XXVI) into the compound of the formula (Ie), the reaction is generally carried out under nitrating conditions, preferably under the same conditions of converting the compound of the formula (VII) into the compound of the formula (Ia) as described in
25 Method 1.

Desired products can be isolated and purified by general methods, for example, column chromatography or recrystallization.

As described above, the pharmaceutical composition according to the present
30 invention including the colchicine derivative of the formula (I) and its pharmaceutically acceptable salt as effective components can be used for gout

treatment agents, anticancer agents, anti-proliferous agents, anti-inflammatory agents, immunosuppressive agents and muscle relaxing agents.

The pharmaceutical composition according to the present invention can be prepared in various parenterally or orally administrable formulations. Typical
5 examples of formations for parenteral administration preferably include in the form of an isotonic aqueous saline solution or suspension for injection. Examples of formulations for oral administration include tablets, capsules and the like, which may further contain a diluent (e.g.: lactose, dextrose, sucrose, mannitol, sorbitol, cellulose and/or glycine) or a lubricant (e.g.: silica, talc, stearic acid and its magnesium or
10 potassium salt, and/or polyethylene glycol) in addition to effective components. Tablets can further be prepared with a binder such as magnesium aluminum silicate, starch paste, gelatins, tragacanth, methylcellulose, sodium carboxymethylcellulose and/or polyvinylpyrrolidone. In some cases, there may be further contained an disintegrator such as starch, agar, and alginate or sodium salts thereof, boiling
15 mixtures and/or absorbents, a coloring agent, a flavoring agent, or a sweetener. The formulations can be prepared by general techniques of mixing, granulation or coating.

The pharmaceutical composition according to the present invention is sterilized and/or contains additives such as an antiseptic, a stabilizer, a hydrator or emulsifier, osmosis adjusting salts and/or a buffering agent, and other therapeutically
20 effective materials. These preparations can be formulated in accordance with known methods usually employed in the formulation process.

As the effective components of the pharmaceutical composition of the present invention, the colchicine derivative of the formula (I) and its pharmaceutically acceptable salt can be administered to mammals including humans through parenteral
25 or oral routes in an amount of 1 to 200 mg/kg (body weight) once or several times per a day.

Examples

The present invention will be further described by the following Examples,
30 but the Examples do not limit the scope of the invention.

7-deacetylcolchicine used in Examples was synthesized according to the

method of the reference EP 0 493 064 and Synthetic Communications 1997, 27(2), 293-296.

The preparation of the thiodeacetylcolchicine was carried out in accordance with the method of WO 9421598 and Bioorganic & Medicinal Chemistry, Vol 5, No. 12, pp 2277-2282(1997).

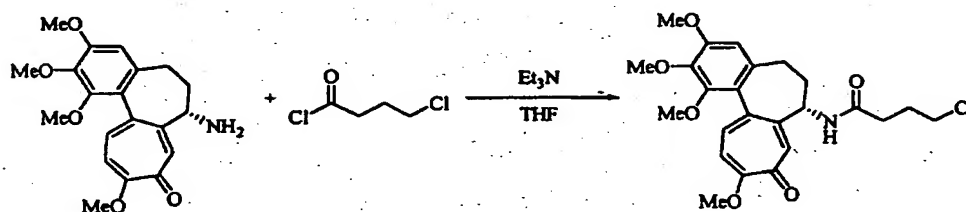
The preparation of N-(10-amino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydrobenzo[a]heptarene-7-yl)acetamide was carried out in accordance with the method of WO 9421598.

The preparation of 4-hydroxymethylcolchicine and 4-hydroxy-methylthiocolchicine was carried out in accordance with the method of the Brevet Canadien 778369 and Justus Liebigs Ann. Chem. 662, 105-113 (1963).

The preparation of 7-hydroxy-1,2,3-trimethoxy-10-methylsulphenyl-6,7-dihydro-5H-benzo[a]heptarene-9-on and colchicone was carried out in accordance with the method of the J. Med. Chem. Vol.40, 961-965 (1997).

Example 1

Preparation of 4-chloro-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydrobenzo[a]heptarene-7-yl)-butylamide



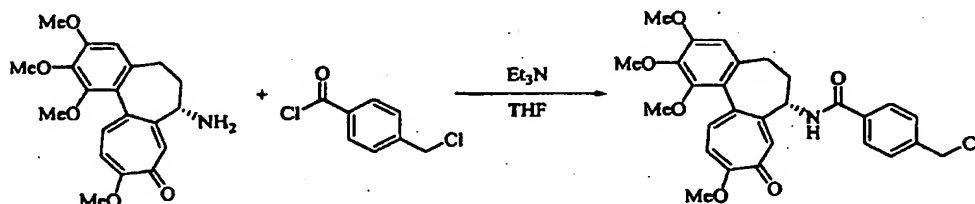
0.1g (0.28mmol) of deacetylcolchicine was placed into a 10ml flask and 3.5ml of tetrahydrofuran was added thereto and then dissolved. To the mixture, 0.2ml (1.40mmol) of triethylamine was added dropwise and 0.035ml (0.31mmol) of 4-chlorobutyryl chloride was added slowly. The mixture was stirred for 2 hours, and then extracted with chloroform and dried over anhydrous magnesium sulfate and filtered. The solvent in the mixture was removed under reduced pressure. The concentrated product was purified by the column chromatography (ethylacetate: methanol = 85:15) to obtain the title product:

^1H NMR (500 MHz, CDCl_3) δ : 1.87-1.91 (m, 1H), 2.00-2.04 (m, 2H),

2.29-2.54 (m, 5H), 3.50 (t, $J = 4.3$ Hz, 2H), 3.67 (s, 3H), 3.91 (s, 3H), 3.95 (s, 3H), 4.01 (s, 3H), 4.65-4.68 (m, 1H), 6.54 (s, 1H), 6.88 (d, $J = 11.0$ Hz, 1H), 7.35 (d, $J = 11.0$ Hz, 1H), 7.51 (d, $J = 6.5$ Hz, 1H), 7.52 (s, 1H)

Example 2

5 Preparation of 4-chloromethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide

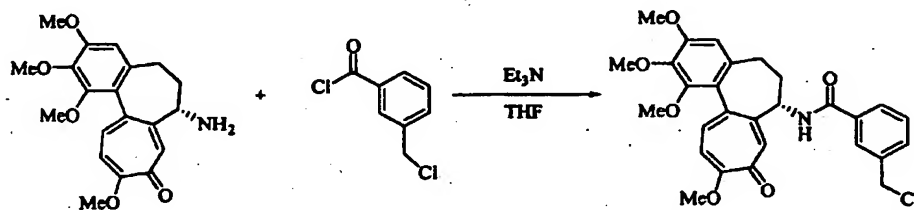


0.12g of title compound 2 (yields: 79%, as a yellow solid) was obtained in accordance with the same method with Example 1 except that 3-chloromethylbenzoyl chloride was used instead of 4-chlorobutyryl chloride:

¹H NMR (500 MHz, CDCl₃) δ :2.05-2.06 (m, 1H), 2.36-2.42 (m, 2H), 2.52-2.52 (m, 1H), 3.75 (s, 3H), 3.91 (s, 3H), 3.96 (s, 3H), 4.00 (s, 3H), 4.44 (s, 2H), 4.86-4.88 (m, 1H), 6.55 (s, 1H), 6.90 (d, $J = 11.0$ Hz, 1H), 7.18 (d, $J = 8.5$ Hz, 2H), 7.39 (d, $J = 11.0$ Hz, 1H), 7.69 (s, 1H), 7.78 (d, $J = 8.5$ Hz, 2H), 8.40 (d, $J = 6.5$ Hz, 1H)

Example 3

Preparation of 3-chloromethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide



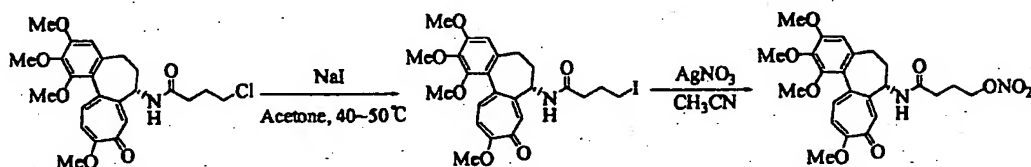
20 0.13g of the title compound 3 (yields: 92%, as a yellow solid) was carried out in accordance with the same method with Example 1 except that 4-chloromethyl benzoyl chloride was used instead of 4-chlorobutyryl chloride:

¹H NMR (500 MHz, CDCl₃) δ :2.22-2.26 (m, 1H), 2.39-2.48 (m, 2H),

2.53-2.57 (m, 1H), 3.75 (s, 3H), 3.95 (s, 3H), 3.97 (s, 3H), 4.01 (s, 3H),
 4.90-4.95 (m, 1H), 5.30 (d, 12.0 Hz, 1H), 5.36 (d, 12.0 Hz, 1H), 6.56 (s, 1H),
 6.93 (d, $J = 11.0$ Hz, 1H), 7.12 (t, $J = 7.5$ Hz, 1H), 7.30 (d, $J = 7.5$ Hz, 1H), 7.41
 (d, $J = 11.0$ Hz, 1H), 7.56 (d, $J = 7.5$ Hz, 1H), 7.69 (s, 1H), 7.77 (s, 1H), 8.44
 (d, $J = 6.5$ Hz, 1H)

Example 4

Preparation of 4-nitrooxy-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-
 benzo[a]heptarene-7-yl)-butylamide



10

0.1g (0.22mmol) of the compound 1 obtained from the Example 1 was placed
 into a 10ml flask and dissolved by adding the 5 ml of acetone. 0.097g (0.065 mmol)
 of sodium iodide was added dropwise thereto, and then the mixture was stirred at
 temperature of 40~50°C for 12 hours. The mixture was extracted with chloroform,
 dried over anhydrous magnesium sulfate and filtered, and then concentrated under
 reduced pressure to obtain 4-iodo-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-
 tetrahydro-benzo[a]heptarene-7-yl)-butylamide (intermediate compound 1) (the first
 step reaction). The concentrated intermediate compound 1 and 2ml of acetonitrile
 were placed into a 25ml flask and 0.15g (0.87mmol) of silver nitrate was added
 thereto. After stirring for 12 hours, the mixture was filtered. The solvent was
 removed under reduced pressure. Chloroform was added thereto and the mixture
 was dried over sodium sulfate and filtered under reduced pressure. The resulting
 compound was purified by the column chromatography (ethylacetate:methanol =
 85:15) to obtain the title compound 4 as a yellow solid (53mg, yields of the second
 step: 50%) (the second step reaction).

25

¹H NMR of the intermediate compound 1:

¹H NMR (500 MHz, CDCl₃) δ :1.86-1.89 (m, 1H), 2.02-2.07 (m, 2H),
 2.18-2.25 (m, 1H), 2.35-2.47 (m, 3H), 2.51-2.55 (m, 1H), 3.55 (t, 2H), 3.65 (s,

3H), 3.90 (s, 3H), 3.94 (s, 3H), 3.99 (s, 3H), 4.61-4.66 (m, 1H), 6.54 (s, 1H), 6.82 (d, 1H), 7.30 (d, 1H), 7.44 (s, 1H), 7.46 (d, 1H)

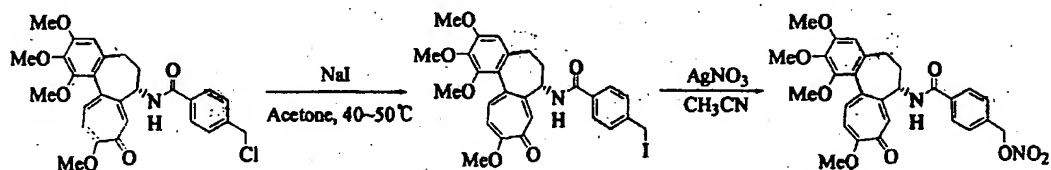
¹H NMR of the Compound 4:

¹H NMR (500 MHz, CDCl₃) δ : 1.96-1.20 (m, 3H), 2.29-2.39 (m, 4H), 2.51-2.52 (m, 1H), 3.66 (s, 3H), 3.91 (s, 3H), 3.95 (s, 3H), 4.01 (s, 3H), 4.40-4.44 (m, 2H), 4.65-4.67 (m, 1H), 6.54 (s, 1H), 6.89 (d, *J* = 11.0 Hz, 1H), 7.36 (d, *J* = 11.0 Hz, 1H), 7.51 (s, 1H), 7.55 (d, *J* = 6.5 Hz, 1H)

MS *m/z* (relative intensity): 977.349([2M+H]⁺, 17), 846.271(6), 527.12 (9), 489.165([M+H]⁺, 100), 358.170([M+H]⁺-CO(CH₂)₃ONO₂, 48), 341.46(48)

10 Example 5

Preparation of 4-nitrooxymethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide



33mg of the title compound 5 (yields of the second step reaction: 45%, as a yellow solid) was prepared by the same method of Example 4 through 4-iodomethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide (intermediate compound 2) except for using compound 2 obtained from the Example 2.

¹H NMR of intermediate compound 2:

¹H NMR (500 MHz, CDCl₃) δ : 2.01-2.09 (m, 1H), 2.31-2.45 (m, 2H), 2.51-2.55 (m, 1H), 3.75 (s, 3H), 3.91 (s, 3H), 3.96 (s, 3H), 4.00 (s, 2H), 4.86-4.89 (m, 1H), 6.54 (s, 1H), 6.90 (d, 1H), 7.19 (d, 2H), 7.38 (d, 1H), 7.67 (s, 1H), 7.71 (d, 2H), 8.28 (d, *J* = 6.5 Hz, 1H)

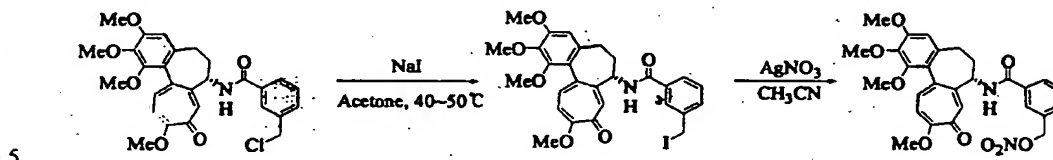
¹H NMR of compound 5:

¹H NMR (500 MHz, CDCl₃) δ : 2.02-2.09 (m, 1H), 2.35-2.58 (m, 3H), 3.76 (s, 3H), 3.91 (s, 3H), 3.97 (s, 3H), 4.01 (s, 3H), 4.86-4.91 (m, 1H), 5.30 (s, 2H), 6.56 (s, 1H), 6.92 (d, *J* = 11.0 Hz, 1H), 7.19 (d, *J* = 8.2 Hz, 2H), 7.41 (d, *J* = 11.0 Hz, 1H), 7.70 (s, 1H), 7.81 (d, *J* = 8.2 Hz, 2H), 8.36 (d, *J* = 6.5 Hz,

1H)

Example 6

Preparation of 3-nitrooxymethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide



25mg of the title compound 6 (yields of the second step reaction: 42%, as a yellow solid) was prepared by the same method of Example 4 through 3-iodomethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide (intermediate compound 3) except for using compound 3 obtained from the Example 3.

¹H NMR of the intermediate compound 3:

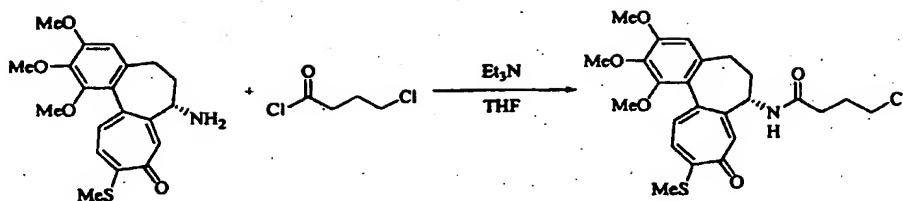
¹H NMR (500 MHz, CDCl₃) δ :2.23-2.31 (m, 1H), 2.38-2.48 (m, 2H), 2.56-2.60 (m, 1H), 3.74 (s, 3H), 3.92 (s, 3H), 3.97 (s, 3H), 3.99 (s, 3H), 4.23 (d, 1H), 4.28 (d, 1H), 4.88-4.95 (m, 1H), 6.59 (s, 1H), 7.03 (d, 1H), 7.13 (t, 1H), 7.33 (d, 1H), 7.45 (d, 1H), 7.59 (d, 1H), 7.70 (s, 1H), 7.78 (s, 1H), 8.44 (d, 1H)

¹H NMR of the compound 6:

¹H NMR (500 MHz, CDCl₃) δ :2.23-2.31 (m, 1H), 2.40-2.50 (m, 2H), 2.55-2.61 (m, 1H), 3.76 (s, 3H), 3.92 (s, 3H), 3.98 (s, 3H), 4.02 (s, 3H), 4.89-4.94 (m, 1H), 5.10 (d, *J* = 12.3 Hz, 1H), 5.20 (d, *J* = 12.3 Hz, 1H), 6.57 (s, 1H), 6.94 (d, *J* = 11.0 Hz, 1H), 7.14 (t, *J* = 7.9 Hz, 1H), 7.28 (d, *J* = 7.9 Hz, 1H), 7.44 (d, *J* = 11.0 Hz, 1H), 7.60 (d, *J* = 7.9 Hz, 1H), 7.70 (s, 1H), 7.81 (s, 1H), 8.56 (d, *J* = 6.5 Hz, 1H)

Example 7

Preparation of 4-chloro-N-(1,2,3-trimethoxy-10-methyl-sulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide.

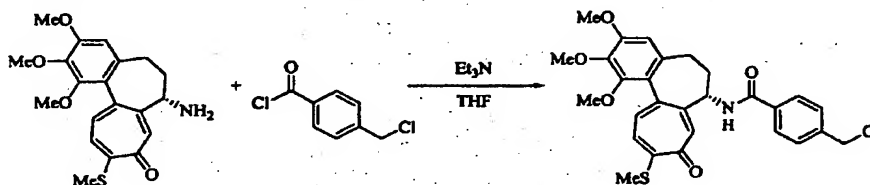


0.13g of the title compound 7 (yields: 86%, as a yellow solid) was prepared by the same method of Example 1 except that thioacetylcolchicine was used instead of deacetylcolchicine.

¹H NMR (500 MHz, CDCl₃) δ : 1.86-1.93 (m, 1H), 2.00-2.10 (m, 2H), 2.23-2.31 (m, 1H), 2.37-2.55 (m, 4H), 2.45 (s, 3H), 3.53 (td, *J* = 6.5, 1.5 Hz, 2H), 3.67 (s, 3H), 3.91 (s, 3H), 3.95 (s, 3H), 4.68-4.73 (m, 1H), 6.54 (s, 1H), 7.09 (d, *J* = 10.6 Hz, 1H), 7.32 (d, *J* = 10.6 Hz, 1H), 7.35 (d, *J* = 7.3 Hz, 1H), 7.42 (s, 1H)

Example 8

Preparation of 4-chloro-N-(1,2,3-trimethoxy-10-methylsulfonyl-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide

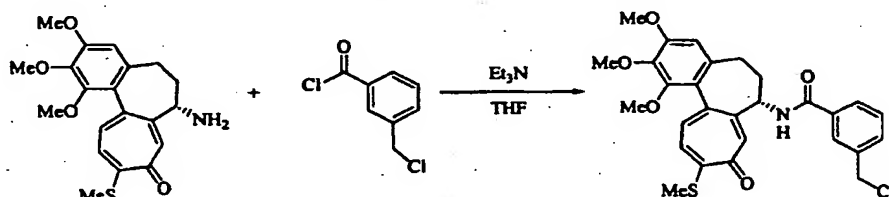


0.12 g of the title compound 8 (yields: 89%, as a yellow solid) was prepared by the same method of Example 1 except that thioacetylcolchicine and 3-chloromethylbenzoyl chloride were used instead of deacetylcolchicine and 4-chlorobutyryl chloride, respectively.

¹H NMR (500 MHz, CDCl₃) δ : 2.09-2.15 (m, 1H), 2.31-2.38 (m, 1H), 2.41-2.48 (m, 1H), 2.44 (s, 3H), 2.55-2.59 (m, 1H), 3.75 (s, 3H), 3.91 (s, 3H), 3.97 (s, 3H), 4.47 (s, 2H), 4.90-4.95 (m, 1H), 6.56 (s, 1H), 7.10 (d, *J* = 10.6 Hz, 1H), 7.25 (d, *J* = 8.2 Hz, 2H), 7.35 (d, *J* = 10.6 Hz, 1H), 7.56 (s, 1H), 7.84 (d, *J* = 8.2 Hz, 2H), 8.11 (d, *J* = 7.3 Hz, 1H)

Example 9

Preparation of 3-chloromethyl-N-(1,2,3-trimethoxy-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide

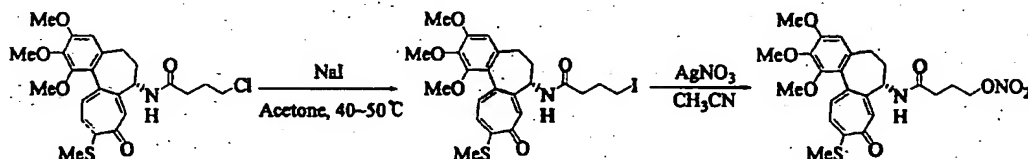


0.15g of the title compound 9 (yields: 90%, as a yellow solid) was prepared by the same method of Example 1 except that thiodeacetylcolchicine and 4-chloromethylbenzoyl chloride were used instead of deacetylcolchicine and 4-chlorobutyryl chloride, respectively.

^1H NMR (500 MHz, CDCl_3) δ : 2.20-2.25 (m, 1H), 2.33-2.49 (m, 2H), 2.45 (s, 3H), 2.56-2.60 (m, 1H), 3.75 (s, 3H), 3.92 (s, 3H), 3.96 (s, 3H), 4.37 (d, 11.7 Hz, 1H), 4.41 (d, 11.7 Hz, 1H), 4.93-4.98 (m, 1H), 6.57 (s, 1H), 7.13 (d, $J = 10.6$ Hz, 1H), 7.17 (t, $J = 7.6$ Hz, 1H), 7.34 (d, $J = 7.6$ Hz, 1H), 7.38 (d, $J = 10.6$ Hz, 1H), 7.65 (s, 1H), 7.67 (d, $J = 7.6$ Hz, 1H), 7.77 (s, 1H), 8.35 (d, $J = 7.3$ Hz, 1H)

Example 10

Preparation of 4-nitroxy-N-(1,2,3-trimethoxy-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide



30mg of the title compound 10 (yields of second step reaction: 33%, as a yellow solid) was prepared by the same method of Example 4 through 4-iodo-N-(1,2,3-trimethoxy-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide (intermediate compound 4) except for using compound 7 obtained from the Example 7.

^1H NMR of intermediate compound 4:

^1H NMR (500 MHz, CDCl_3) δ : 1.92-1.98 (m, 1H), 2.01-2.12 (m, 2H),

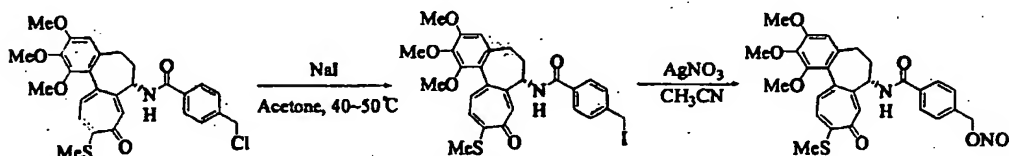
2.24-2.55 (m, 5H), 2.45 (s, 3H), 3.50-3.54 (m, 2H), 3.68 (s, 3H), 3.91 (s, 3H),
3.95 (s, 3H), 4.71-4.74 (m, 1H), 6.55 (s, 1H), 7.11 (d, 1H), 7.34 (d, 1H),
7.53 (s, 1H), 7.98 (d, 1H)

¹H NMR of compound 10:

5 ¹H NMR (500 MHz, CDCl₃) δ :1.87-1.93 (m, 1H), 1.96-2.06 (m, 2H),
2.24-2.55 (m, 5H), 2.45 (s, 3H), 3.67 (s, 3H), 3.91 (s, 3H), 3.95 (s, 3H),
4.42-4.47 (m, 2H), 4.70-4.75 (m, 1H), 6.54 (s, 1H), 7.11 (d, *J* = 10.6 Hz, 1H),
7.34 (d, *J* = 10.6 Hz, 1H), 7.49 (s, 1H), 7.69 (d, *J* = 7.6 Hz, 1H)

Example 11

10 Preparation of 4-nitrooxymethyl-N-(1,2,3-trimethoxy-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide



75 mg of the title compound 11 (yields of second step reaction: 58%, as a
yellow solid) was prepared by the same method of Example 4 through
15 4-iodomethyl-N-(1,2,3-trimethoxy-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-
benzo[a]heptarene-7-yl)-benzamide (intermediate compound 5) except for using
compound 8 obtained from the Example 8.

¹H NMR of intermediate compound 5:

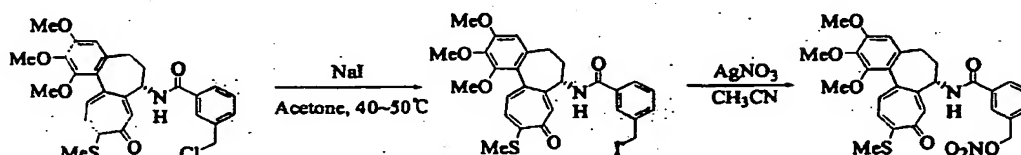
20 ¹H NMR (500 MHz, CDCl₃) δ :2.15-2.20 (m, 1H), 2.28-2.35 (m, 1H),
2.38-2.44 (m, 1H), 2.44 (s, 3H), 2.53-2.56 (m, 1H), 3.75 (s, 3H), 3.90 (s, 3H),
3.96 (s, 3H), 4.27 (s, 2H), 4.92-4.97 (m, 1H), 6.56 (s, 1H), 7.12 (d, 1H),
7.17 (d, 2H), 7.36 (d, 1H), 7.67 (s, 1H), 7.80 (d, 2H), 8.67 (d, 1H)

¹H NMR of compound 11:

25 ¹H NMR (500 MHz, CDCl₃) δ :2.14-2.20 (m, 1H), 2.30-2.48 (m, 2H),
2.45 (s, 3H), 2.55-2.59 (m, 1H), 3.76 (s, 3H), 3.91 (s, 3H), 3.97 (s, 3H),
4.93-4.98 (m, 1H), 5.29 (s, 2H), 6.56 (s, 1H), 7.13 (d, *J* = 10.6 Hz, 1H), 7.20
(d, *J* = 8.5 Hz, 2H), 7.37 (d, *J* = 10.6 Hz, 1H), 7.66 (s, 1H), 7.90 (d, *J* = 8.5 Hz,
2H), 8.64 (d, *J* = 7.3 Hz, 1H)

Example 12

Preparation of 3-nitrooxymethyl-N-(1,2,3-trimethoxy-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide



70mg of the title compound 12 (yields of second step reaction: 64%, as a yellow solid) was prepared by the same method of Example 4 through 3-iodomethyl-N-(1,2,3-trimethoxy-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide (intermediate compound 6) except for using compound 9 obtained from the Example 9.

¹H NMR of intermediate compound 6:

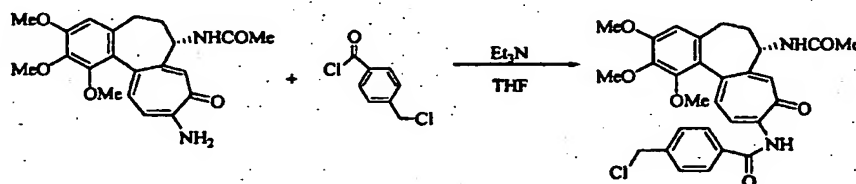
¹H NMR (500 MHz, CDCl₃) δ :2.26-2.45 (m, 3H), 2.45 (s, 3H), 2.54-2.58 (m, 1H), 3.75 (s, 3H), 3.91 (s, 3H), 3.97 (s, 3H), 4.16 (d, 1H), 4.23 (d, 1H), 4.95-5.00 (m, 1H), 6.57 (s, 1H), 7.05 (t, 1H), 7.16 (d, 1H), 7.26 (d, 1H), 7.39 (d, 1H), 7.60 (d, 1H), 7.77 (s, 1H), 7.80 (s, 1H), 8.82 (d, 1H)

¹H NMR of compound 12:

¹H NMR (500 MHz, CDCl₃) δ :2.31-2.47 (m, 3H), 2.45 (s, 3H), 2.57-2.61 (m, 1H), 3.77 (s, 3H), 3.92 (s, 3H), 3.98 (s, 3H), 4.94-4.99 (m, 1H), 5.10 (d, 12.0 Hz, 1H), 5.18 (d, 12.0 Hz, 1H), 6.57 (s, 1H), 7.12 (t, *J* = 7.6 Hz, 1H), 7.18 (d, *J* = 10.6 Hz, 1H), 7.25 (d, *J* = 7.6 Hz, 1H), 7.42 (d, *J* = 10.6 Hz, 1H), 7.69 (s, 1H), 7.78-7.79 (m, 2H), 9.02 (d, *J* = 7.3 Hz, 1H)

Example 13

Preparation of N-(7-acetylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-10-yl)-4-chloromethyl-benzamide

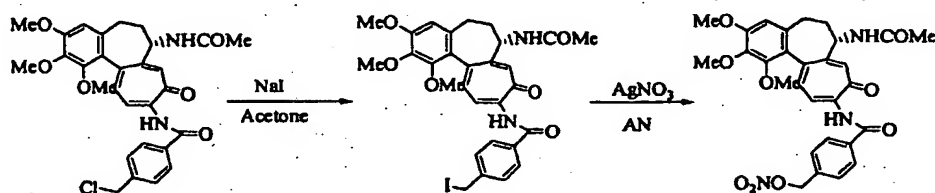


1g (26mmol) of N-(10-amino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro benzo[a]heptarene-7-yl) acetamide was placed into a 25ml flask and dissolved with 10ml of tetrahydrofuran. 2.8ml (20 mmol) of triethylamine was added thereto dropwise, and then the mixture was stirred for 30 minutes. 0.55g (2.9mmol) of 4-chloromethylbenzoyl chloride was added thereto and dissolved with stirring at room temperature for 48 hours, extracted with chloroform, dried over anhydrous magnesium sulfate and then filtered. After concentrating under reduced pressure, the concentrated resulting compound was purified through the column chromatography (chloroform: methanol=9:1) to obtain 1.36g of the title compound 13 (yields: 98%, as a yellow solid).

¹H NMR (500 MHz, CDCl₃) δ : 1.87(m, 1H), 2.02(s, 3H), 2.39(m, 1H), 2.41(m, 1H), 2.53(m, 1H), 3.67(s, 3H), 3.91 (s, 3H), 3.92 (s, 3H), 4.68 (s, 2H), 4.71 (m, 1H), 6.54 (s, 1H), 6.94(d, J=10.0Hz, 1H), 7.54~7.67 (m, 4H), 8.00 (m, 2H), 9.21(d, J=10.9Hz, 1H), 10.32(s, 1H)

Example 14

Preparation of N-(7-acetylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-10-yl)-4-nitrooxymethyl-benzamide



The compound 13 obtained from the Example 13 was dissolved using 5ml of acetone. 0.072g (0.48mmol) of the sodium iodide was added dropwise thereto. After stirring at 40~50°C for 24 hours, the mixture was extracted with chloroform, dried over anhydrous magnesium sulfate and filtered. The mixture was concentrated under reduced pressure to obtain N-(7-acetylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-10-yl)-4-iodidmethyl benzamide (intermediate compound 7). 0.0205g (0.033mmol) of the concentrated intermediate compound 7 and 0.2ml of the acetonitrile were placed into a 25ml flask and 0.022g (0.13mmol) of silver nitrate was added thereto. After stirring for 24 hours, the mixture was filtered,

and followed by concentrating under reduced pressure, and chloroform was added thereto. The resulting mixture was dried over sodium sulfate, filtered, and followed by concentrating under reduced pressure. 18mg of the title compound 14 (yields of second step reaction: 96%, as a yellow solid) was obtained after purification by column chromatography (chloroform : methanol = 9:1)

¹H NMR of intermediate compound 7:

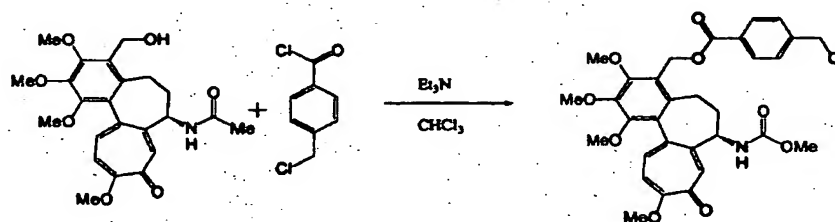
¹H NMR (500 MHz, CDCl₃) δ : 1.85 (m, 1H), 2.02 (s, 3H), 2.29 (m, 1H), 2.40 (m, 1H), 2.54 (m, 1H), 3.66 (s, 3H), 3.91 (s, 3H), 3.95 (s, 3H), 4.50 (s, 2H), 4.69 (m, 1H), 6.54 (s, 1H), 6.85 (d, J=6.75Hz, 1H), 7.53 (m, 3H), 7.60 (s, 1H), 7.93 (d, J=8.2Hz, 2H), 9.20 (d, J=10.9Hz, 1H), 10.30 (s, 1H)

¹H NMR of compound 14:

¹H NMR (500 MHz, CDCl₃) δ : 1.85 (m, 1H), 2.02 (s, 3H), 2.29 (m, 1H), 2.41 (m, 1H), 2.54 (m, 1H), 3.66 (s, 3H), 3.91 (s, 3H), 3.94 (s, 3H), 4.69 (m, 1H), 5.52 (s, 2H), 6.54 (s, 1H), 6.73 (d, J=6.8Hz, 1H), 7.51–7.60 (m, 4H), 8.03 (m, 2H), 9.19 (d, J=10.9Hz, 1H), 10.33 (s, 1H)

Example 15

Preparation of 4-chloromethyl-benzoic acid-7-acetyl-amino-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl-methyl ester



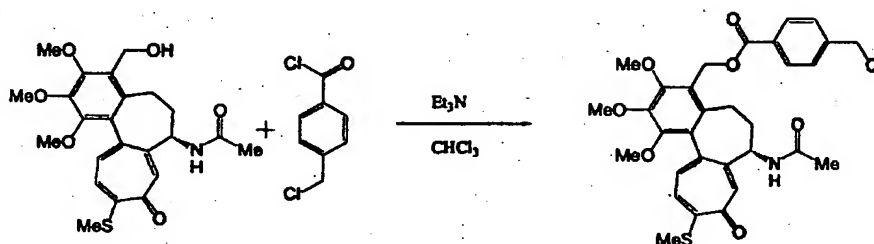
0.05g (0.12mmol) of 4-hydroxymethylcolchicine (N-(4-hydroxymethyl-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]-heptarene-7-yl)-acetamide) was placed into a 10ml flask and 3.5ml of chloroform was added thereto to dissolve the compound. To the mixture, 0.13ml (0.096mmol) of triethylamine was added dropwise and then 0.088mg (0.48mmol) of 4-chloromethylbenzoyl chloride was added slowly. After stirring for 18 hours, the mixture was extracted with chloroform, dried and filtered over anhydrous magnesium sulfate, and the solvent was removed

under reduced pressure. Concentrated resulting compounds was purified using the column chromatography (ethylacetate:methanol = 85:15) to obtain 0.034 g of the title compound 15 (yields: 50.2%) as a white solid.

¹H NMR (500 MHz, CDCl₃) δ : 1.85-1.87(m, 1H), 1.99(s, 3H), 2.21-2.23(m, 2H), 2.92-2.94(m, 1H), 3.67(s, 3H), 3.98(s, 3H), 4.00(s, 3H), 4.02(s, 3H), 4.61(s, 3H), 4.67-4.69(m, 1H), 5.40(d, *J*=11.15Hz, 1H), 5.46(d, *J*=11.15Hz, 1H), 6.86 (d, *J*=11.15Hz, 1H), 7.30 (d, *J*= 10.85Hz, 1H), 7.45(d, *J*=8.80Hz, 2H), 7.55(s, 1H), 7.80(d, *J*=6.75Hz, 1H), 8.03(d, *J*=8.80Hz, 2H)

Example 16

Preparation of 4-chloromethyl-benzoic acid-7-acetylamino-1,2,3-trimethoxy-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl-methyl-ester

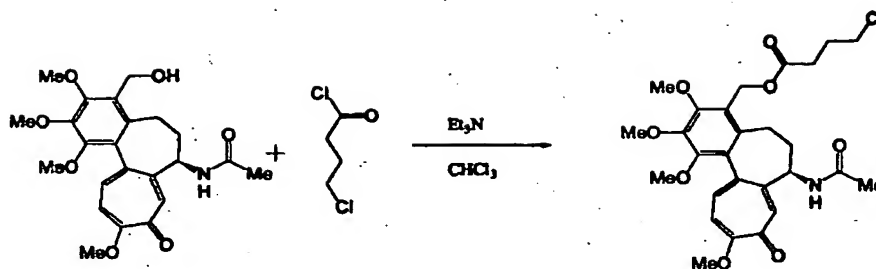


0.12g of the title compound 16 (yields: 40%, as a yellow solid) was prepared by the same method of Example 15 except that 4-hydroxymethylthiocolchicine was used instead of 4-hydroxymethylcolchicine.

¹H NMR (500 MHz, CDCl₃) δ : 1.83-1.85(m, 1H), 2.02(s, 3H), 2.19-2.21(m, 2H), 2.43(s, 3H), 2.92-2.94(m, 1H), 3.67(s, 3H), 3.98(s, 3H), 4.00(s, 3H), 4.61(s, 2H), 4.64-4.66(m, 1H), 5.41(d, *J*=11.15Hz, 1H), 5.46(d, *J*= 11.15Hz, 1H), 7.06 (d, *J*=10.56Hz, 1H), 7.27(d, *J*= 9.39Hz, 1H), 7.38(s, 1H), 7.45(d, *J*=8.51Hz, 2H), 7.50 (d, *J*=7.33Hz, 1H), 8.03(d, *J*=8.51Hz, 2H)

Example 17

Preparation of 4-chlorobutyric acid-7-acetylamino-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl-methyl ester

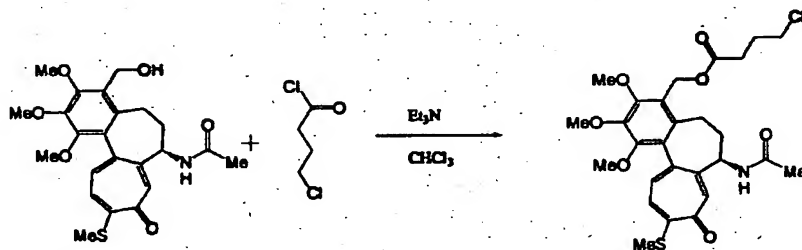


0.13g of the title compound 17 (yields: 92%, as a yellow solid) was prepared by the same method of Example 15 except that 4-chlorobutyryl chloride was used instead of 4-chloromethylbenzoyl chloride.

¹H NMR (500 MHz, CDCl₃) δ : 1.91-1.93(m, 1H), 2.00(s, 3H), 2.10-2.12(m, 2H), 2.23-2.25(m, 2H), 2.55(t, *J*=7.04Hz, 2H), 2.82- 2.84(m, 1H), 3.63(t, *J*=6.16Hz, 2H), 3.65(s, 3H), 3.96(s, 3H), 3.98(s, 3H), 4.03(s, 3H), 4.63-4.66(m, 1H), 5.12(d, *J*=12.91Hz, 1H), 5.27(d, *J*=12.91Hz, 1H), 6.90(d, *J*=11.15Hz, 1H), 7.30(d, *J*=9.68Hz, 1H), 7.61(s, 1H), 8.21(d, *J*=6.45Hz, 1H)

Example 18

Preparation of 4-chloro-butyric acid-7-acetylthio-1,2,3-trimethoxy-10-methyl-sulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl-methyl ester



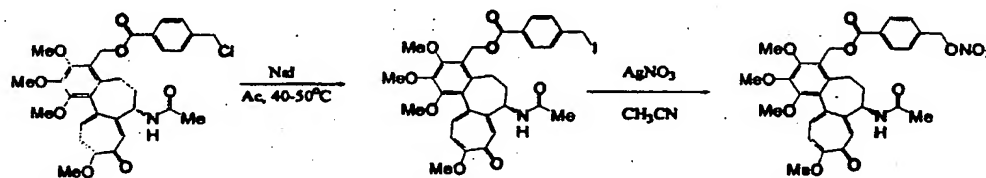
0.13g of the title compound 18 (yields: 92%, as a yellow solid) was prepared by the same method of Example 15 except that 4-hydroxymethyl thiolcolchicine and 4-chlorobutyryl chloride were used instead of 4-hydroxymethyl colchicine and 4-chloromethylbenzoyl chloride, respectively.

¹H NMR (500 MHz, CDCl₃) δ : 1.85-1.87(m, 1H), 2.03(s, 3H), 2.12-2.14(m, 2H), 2.19-2.21(m, 2H), 2.45(s, 3H), 2.53(t, *J*=7.33Hz, 2H), 2.81-2.83(m, 1H), 3.60(t,

$J=6.75\text{Hz}$, 2H), 3.65(s, 3H), 3.96 (s,3H), 3.98(s, 3H), 4.64-4.66(m, 1H), 5.17(d, $J=12.03\text{Hz}$, 1H), 5.26(d, $J=12.03\text{Hz}$, 1H), 7.07(d, $J=10.56\text{Hz}$, 1H), 7.26(d, $J=10.27\text{Hz}$, 1H), 7.37(s,1H), 7.40(d, $J=7.04\text{Hz}$, 1H)

Example 19

- 5 Preparation of 4-nitrooxymethyl-benzoic acid-7-acetyl-amino-1,2,3,10-tetra-methoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl-methyl-ester



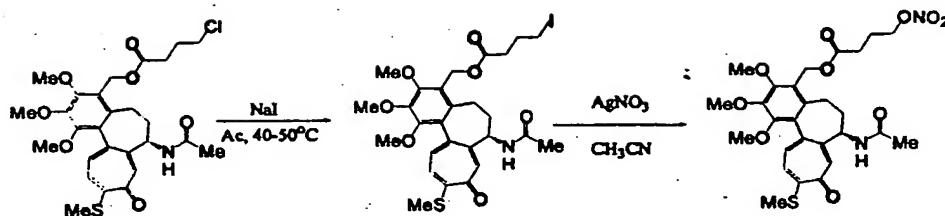
- 0.084g (0.14mmol) of the compound 15 obtained from the Example 15 (0.14mmol) was placed into the flask and then dissolved by adding 5 ml of acetone.
- 10 After adding 0.086g of sodium iodide(0.057mmol) dropwisely thereto, the mixture was stirred at 40~50 °C for 12 hours, extracted with chloroform, dried over anhydrous magnesium sulfate, and then concentrated under reduced pressure. Concentrated resulting compound and 2 ml acetonitrile were placed with a 25ml flask and 0.09g (0.53mmol) of silver nitrate was added thereto. The mixture was stirred for 12 hours,
- 15 and the solvent was filtered and removed under reduced pressure. The resulting compound was purified by column chromatography (ethylacetate: methanol = 85:15) to obtain 40mg of the title compound 19 (yields of second step reaction: 46%) as a yellow solid.

¹H NMR of compound 19:

- 20 ¹H NMR (500 MHz, CDCl₃) δ :1.86-1.88(m, 1H), 1.77(s, 1H), 2.20-2.22(m, 2H), 2.92-2.94(m, 1H), 3.67(s, 3H), 3.98(s, 3H), 3.99(s,3H), 4.00(s,3H), 4.67-4.69(m, 1H), 5.39-5.47(m, 2H), 5.47(s, 2H), 6.86(d, $J=10.85\text{Hz}$, 1H), 7.30(d, $J=10.85\text{Hz}$, 1H), 7.47(d, $J=8.51\text{Hz}$, 2H), 7.54(s, 1H), 7.76(d, $J=7.04\text{Hz}$, 1H), 8.01(d, $J=8.51\text{Hz}$, 2H)

Example 20

- 25 Preparation of 4-nitrooxymethyl-butyric acid-7-acetyl-amino-1,2,3-trimethoxy-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl-methyl-ester



70mg of the title compound 20 (yields of second step reaction: 39%, as a yellow solid) was prepared by the same method of the Example 19 through 4-iodomethyl-butyrac acid-7-acetyl-amido-1,2,3-trimethoxy-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl-methyl-ester (intermediate compound 8) except for using compound 18 obtained from the Example 18.

¹H NMR of intermediate compound 8:

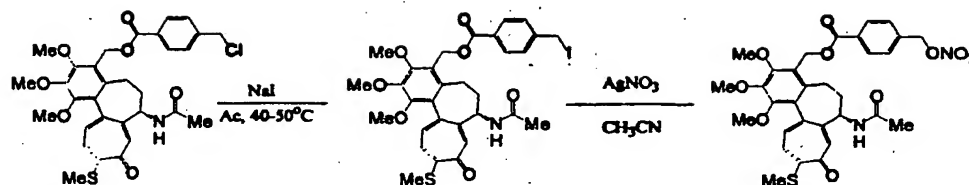
¹H NMR (500 MHz, CDCl₃) δ : 1.82-1.84(m, 1H), 2.02(s, 3H), 2.13-2.15(m, 4H), 2.44(s, 3H), 2.47(t, J=7.04Hz, 2H), 2.82-2.84(m, 1H), 3.24(t, J=6.75Hz, 2H), 3.65(s, 3H), 3.95(s, 3H), 3.97(s, 3H), 4.63-4.65(m, 1H), 5.17(d, J=11.73Hz, 1H), 5.25(d, J=11.73Hz, 1H), 6.65(d, J=7.33Hz, 1H), 7.05(d, J=10.27Hz, 1H), 7.23(d, J=10.27Hz, 1H), 7.27(s, 1H)

¹H NMR of compound 20:

¹H NMR (500 MHz, CDCl₃) δ : 1.90-1.92(m, 1H), 2.02(s, 3H), 2.08- 2.10(m, 2H), 2.18-2.20(m, 2H), 2.45(s, 3H), 2.49(t, J=7.04Hz, 2H), 2.81-2.83(m, 1H), 3.65(s, 3H), 3.96(s, 3H), 3.97(s, 3H), 4.54(t, J=6.45Hz, 2H), 4.65-4.67(m, 1H), 5.18(d, J=11.73, 1H), 5.27(d, J=11.73Hz, 2H), 7.10(d, J=11.15Hz, 1H), 7.26(d, J=9.68Hz, 1H), 7.45(s, 1H), 8.00(d, J=7.04Hz, 1H)

Example 21

Preparation of 4-nitrooxymethyl-benzoic acid-7-acetyl-amino-1,2,3-trimethoxy-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl-methyl- ester



70mg of the title compound 21 (yields of second step reaction: 45%, as a yellow solid) was prepared by the same method of the Example 19 through 4-iodomethyl-benzoic acid-7-acetylamino-1,2,3-trimethoxy-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl-methyl-ester(intermediate compound 9) except for using compound 16 obtained from the Example 16.

¹H NMR of intermediate compound 9:

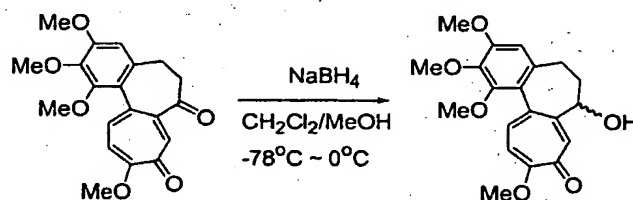
¹H NMR (500 MHz, CDCl₃) δ : 1.74-1.76(m, 1H), 2.23(s, 3H), 2.13- 2.15(m, 1H), 2.23-2.25(m, 1H), 2.43(s, 3H), 2.92-2.94(m, 1H), 3.66 (s, 3H), 3.97(s,3H), 3.99(s, 3H), 4.45(s, 2H), 4.66-4.68(m.1H), 5.40(d, J=12.03Hz, 1H), 5.45(d, J=12.03Hz, 1H), 6.35(d, J=6.45Hz, 1H), 7.05(d, J=9.97Hz, 1H), 7.24(d, J=7.24Hz, 1H), 7.22(s, 1H), 7.41(d, J=8.51Hz, 2H), 7.96(d, J=8.51Hz, 2H)

¹H NMR of compound 21:

¹H NMR (500 MHz, CDCl₃) δ : 1.79-1.81(m, 1H), 2.00(s, 3H), 2.13- 2.15(m, 1H), 2.23-2.25(m, 1H), 2.43(s, 3H), 2.92-2.94(m, 1H), 3.67 (s,3H), 3.97(s,3H), 3.99(s, 3H), 4.66-4.68(m.1H), 5.42-5.47(m, 2H), 5.47(s, 2H), 6.95(d, J=6.75Hz, 1H), 7.05(d, J=10.56Hz, 1H), 7.24(d, J=10.85Hz, 1H), 7.30(s, 1H), 7.46(d, J=8.21Hz, 2H), 8.07(d, J=8.21Hz, 2H)

Example 22

Deacetamidocolchicine-7-ol



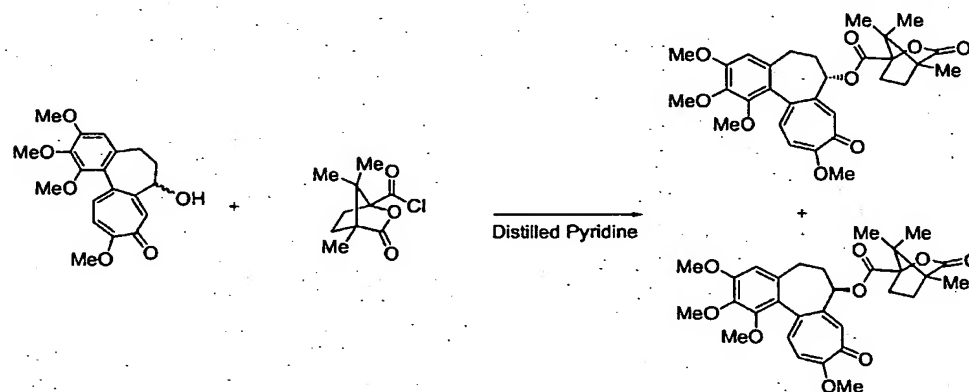
2.29g (6.426mmol) of colchicine, 20ml of methanol and 20ml of chloromethane were placed into a 100ml flask and cooled to -78°C. To the mixture,

0.729g (19.278mmol) of sodium borohydride was added and the mixture was warmed to 0~ -20°C with stirring for 5 hours. The solution was acidified with 50% acetic acid and extracted with chloroform, and then dried over sodium sulfate, filtered and the solvent was removed under reduced pressure. The concentrated resulting compound was recrystallized (methanol/ethylether) to obtain the title compound 22(2.0844g, 90.5%).

¹H NMR (500 MHz, CDCl₃): δ 1.80-1.83 (m, 1H), 2.40-2.49 (m, 3H), 3.26 (br, 1H), 3.60 (s, 3H), 3.90 (s, 3H), 3.91 (s, 3H), 3.97 (s, 3H), 4.46-4.49 (m, 1H), 6.55 (s, 1H), 6.79 (d, J = 11.0 Hz, 1H), 7.18 (d, J = 11.0 Hz, 1H), 7.94 (s, 1H)

Example 23

Preparation of (-)-4,7,7-trimethyl-3-oxo-2-oxa-bicyclo[2.2.1]heptane-1-carboxylic acid-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptalene-7-yl ester and (+)-4,7,7-trimethyl-3-oxo-2-oxa-bicyclo[2.2.1]heptane-1-carboxylic acid-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptalene-7-yl ester



0.5098g (1.4225 mmol) of deacetamidocolchicine-7-ol was placed into a 10ml flask and 8ml of distilled pyridine was added thereto. To the mixture, (-)-camphanic chloride (0.4007g, 1.8492mmol) was added. After 3 hours, 1N hydrochloric acid was added to stop the reaction. The mixture was extracted with ethyl acetate for three times, and then dried over anhydrous sodium sulfate and filtered, and the compound was concentrated under reduced pressure. The concentrated compound was purified by column chromatography (ethyl acetate) to obtain the racemates of the title compounds 23(1) and 23(2). The racemates were separated by MPLC

(ethanol:isopropyl alcohol = 9:1) to obtain the compounds 23(1) (184.6mg, 24.1%) and 23(2) (191.5mg, 25.0%).

¹H NMR of compound 23(1):

¹H NMR (500 MHz, CDCl₃): δ 0.95 (s, 3H), 1.10 (s, 3H), 1.11 (s, 3H),
 5 1.71-1.74 (m, 1H), 1.90-1.93 (m, 1H), 2.05-2.13 (m, 2H), 2.14-2.43 (m, 2H),
 2.49-2.52 (m, 1H), 2.54-2.58 (m, 1H), 3.66 (s, 3H), 3.92 (m, 3H), 3.94 (s, 3H),
 3.99 (s, 3H), 5.41 (dd, J = 7.0, 11.0 Hz, 1H), 6.56 (s, 1H), 6.80 (d, J = 11.0 Hz,
 1H), 7.28 (d, J = 11.0 Hz, 1H), 7.40 (s, 1H)

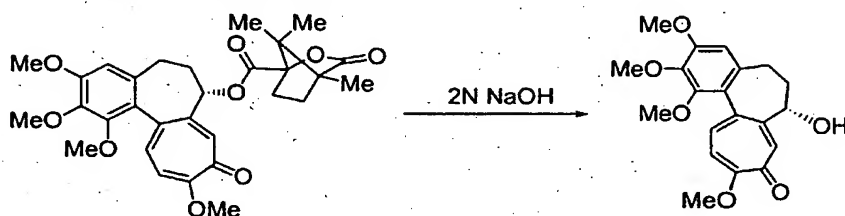
¹H NMR of compound 23(2):

10 ¹H NMR (500 MHz, CDCl₃): δ 1.02 (s, 3H), 1.07 (s, 3H), 1.12 (s, 3H),
 1.71-1.74 (m, 1H), 1.92-1.95 (m, 1H), 2.07-2.11 (m, 2H), 2.35-2.43 (m, 1H),
 2.48-2.56 (m, 3H), 3.66 (s, 3H), 3.91 (m, 1H), 3.94 (s, 3H), 3.99 (s, 3H),
 5.46 (dd, J = 7.0, 11.0 Hz, 1H), 6.56 (s, 1H), 6.80 (d, J = 11.0 Hz, 1H), 7.28 (d,
 = 11.0 Hz, 1H), 7.36 (s, 1H)

15

Example 24

(-)-deacetamidocolchicine-7-ol



184.6mg (0.3427mmol) of the compound 23(1) obtained from the Example 23
 was placed into a 10ml flask, and 2.5ml of methanol and 2.5ml of chloroform were
 20 added thereto. The solution was cooled to -78 °C, and 1.71ml (3.4275mmol) of 2N
 aqueous solution of sodium hydroxide was added into the solution. The mixture was
 warmed to the room temperature and stirred for 3 hours. It was extracted with
 chloroform for three times and washed with water, and then dried over anhydrous
 sodium sulfate. The solvent in the mixture was removed under reduced pressure.
 25 The resulting concentrated product was recrystallized (ethyl acetate/hexane) to obtain
 the title product 24 (128.8mg, 100%).

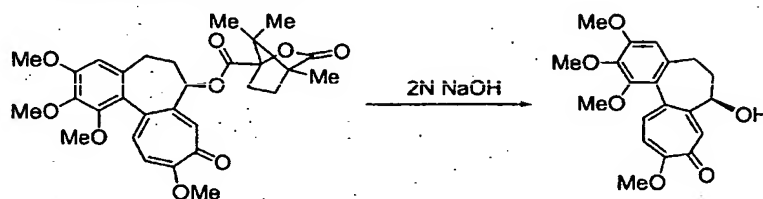
$[\alpha]_D^{25} : -102.55$ (CDCl₃, c = 6.875 x 10⁻³ g/ml)

¹H NMR (500 MHz, CDCl₃): δ 1.80-1.83 (m, 1H), 2.40-2.49 (m, 3H), 3.26 (br, 1H), 3.60 (s, 3H), 3.90 (s, 3H), 3.91 (s, 3H), 3.97 (s, 3H), 4.46-4.49 (m, 1H), 6.55 (s, 1H), 6.79 (d, J = 11.0 Hz, 1H), 7.18 (d, J = 11.0 Hz, 1H), 7.94 (s, 1H)

5

Example 25

(+)-deacetamidocolchicine-7-ol



191.5mg (0.3556mmol) of the compound 23(2) obtained from the Example 23 was added to a 10ml flask, and 2.5ml of methanol and 2.5ml of chloromethane were added thereto. The temperature was cooled down to -78 °C, and 1.78ml (3.5560mmol) of 2N aqueous solution of sodium hydroxide was added thereto. The solution was warmed to the room temperature and stirred for 3 hours. The mixture was extracted with chloroform for three times and washed with water, and dried over anhydrous sodium sulfate and the solvent was removed by concentrating under reduced pressure. The resulting concentrated product was recrystallized (ethyl acetate/hexane) to obtain the title product 25(127.4mg, 100%).

15

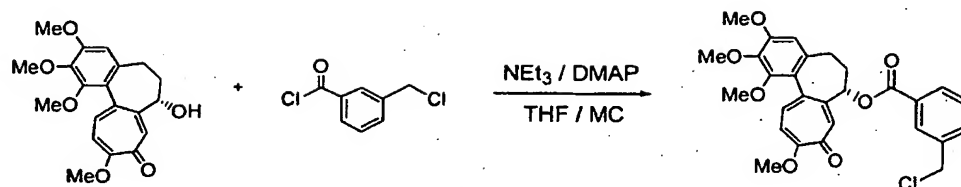
$[\alpha]_D^{25} : +113.10$ (CDCl₃, c = 7.250 x 10⁻³ g/ml)

¹H NMR (500 MHz, CDCl₃): δ 1.80-1.83 (m, 1H), 2.40-2.49 (m, 3H), 3.26 (br, 1H), 3.60 (s, 3H), 3.90 (s, 3H), 3.91 (s, 3H), 3.97 (s, 3H), 4.46-4.49 (m, 1H), 6.55 (s, 1H), 6.79 (d, J = 11.0 Hz, 1H), 7.18 (d, J = 11.0 Hz, 1H), 7.94 (s, 1H)

20

Example 26

(-)-3-chloromethyl-benzoic acid-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-bezo[a]heptarene-7-yl ester

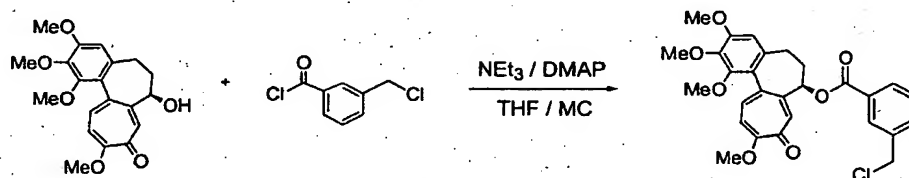


61.2mg (0.171mmol) of (-)-deacetamidocolchicine-7-ol was placed into a 25ml flask, and 1 ml of chloromethane and 2ml of THF were added thereto. To the solution, 26.7 μ l (0.188mmol) of 3-chloromethylbenzoyl chloride was added dropwise and then 71.4 μ l (0.512mmol) of triethylamine was added. 4.2mg (0.0342mmol) of DMAP was added to the mixture and it was stirred at room temperature for 3 hours. The mixture was extracted with chloroform and dried over anhydrous sodium sulfate and concentrated under reduced pressure. The resulting concentrated product was purified with column chromatography (ethyl acetate: methanol = 20:1) to obtain the title product 26 (60.0mg, 68.8%).

^1H NMR (500 MHz, CDCl_3): δ 2.15-2.22 (m, 1H), 2.45-2.64 (m, 3H), 3.70 (s, 3H), 3.92 (s, 3H), 3.96 (s, 3H), 3.99 (s, 3H), 4.62 (s, 1H), 4.63 (s, 1H), 5.57 (dd, $J = 6.5, 5.5$ Hz, 1H), 6.59 (s, 1H), 6.83 (d, $J = 11.0$ Hz, 1H), 7.33 (d, $J = 11.0$ Hz, 1H), 7.46 (t, $J = 7.5$ Hz, 1H), 7.53 (s, 1H), 7.62 (d, $J = 7.5$ Hz, 1H), 8.03 (d, $J = 7.5$ Hz, 1H), 8.06 (s, 1H).

Example 27

(+)-3-chloromethyl-benzoic acid-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptaren-7-yl ester



The title compound 27 (58.7mg, 67.4%) was obtained in accordance with the same method of the Example 26 except that (+)-deacetamidocolchicine-7-ol was used instead of (-)-deacetamidocolchicine-7-ol.

^1H NMR (500 MHz, CDCl_3): δ 2.15-2.22 (m, 1H), 2.45-2.64 (m, 3H), 3.70 (s, 3H), 3.92 (s, 3H), 3.96 (s, 3H), 3.99 (s, 3H), 4.62 (s, 1H), 4.63 (s, 1H), 5.57 (dd, $J = 6.5, 5.5$ Hz, 1H), 6.59 (s, 1H), 6.83 (d, $J = 10.8$ Hz, 1H),

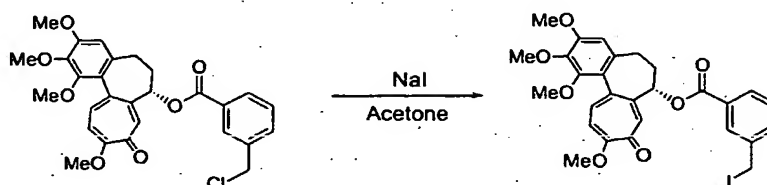
7.33 (d, J = 10.8 Hz, 1H), 7.46 (t, J = 7.5 Hz, 1H), 7.53 (s, 1H), 7.62 (d, J = 7.5 Hz, 1H), 8.03 (d, J = 7.5 Hz, 1H), 8.06 (s, 1H)

Example 28

(-)-3-iodomethyl-benzoic

acid-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-

5 tetrahydro-benzo[a]heptarene-7-yl ester



47.5mg of the title product 28(67.1%) was prepared by the same method of the first step of the Example 4 except for using of compound 26 obtained in the Example 26.

10 ^1H NMR (600 MHz, CDCl_3): δ 2.05-2.22 (m, 1H), 2.46-2.62 (m, 3H), 3.71 (s, 3H), 3.93 (s, 3H), 3.97 (s, 3H), 3.99 (s, 3H), 4.48 (d, J = 9.9 Hz, 1H), 4.50 (d, J = 9.9 Hz, 1H), 5.57 (dd, J = 6.5, 4.3 Hz, 1H), 6.59 (s, 1H), 6.82 (d, J = 10.8 Hz, 1H), 7.33 (d, J = 10.8 Hz, 1H), 7.41 (t, J = 7.8 Hz, 1H), 7.51 (s, 1H), 7.61 (d, J = 7.8 Hz, 1H), 7.96 (d, J = 7.8 Hz, 1H), 8.05 (s, 1H)

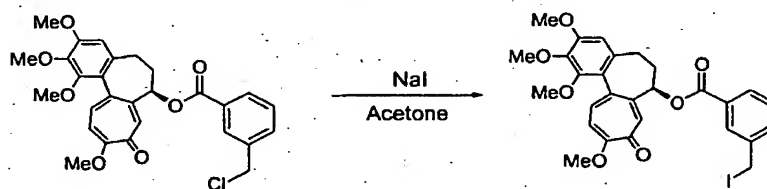
15

Example 29

(+)3-iodomethyl-benzoic

acid-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-

tetrahydro- benzo[a]heptarene-7-yl ester



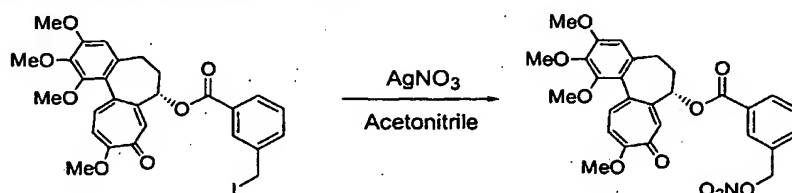
20 47.5mg of the title compound 29 (68.6%) was prepared by the first step of the Example 4 except for using compound 27 obtained the Example 27.

^1H NMR (600 MHz, CDCl_3): δ 2.05-2.22 (m, 1H), 2.46-2.62 (m, 3H), 3.71 (s, 3H), 3.93 (s, 3H), 3.97 (s, 3H), 3.99 (s, 3H), 4.48 (d, J = 9.9 Hz, 1H), 4.50 (d, J = 9.9 Hz, 1H), 5.57 (dd, J = 6.5, 4.3 Hz, 1H), 6.59 (s, 1H), 6.82 (d, J = 10.8 Hz, 1H), 7.33 (d, J = 10.8 Hz, 1H), 7.41 (t, J = 7.8 Hz, 1H), 7.51 (s, 1H), 7.61 (d, J = 7.8 Hz, 1H), 7.96 (d, J = 7.8 Hz, 1H), 8.05 (s, 1H)

25

Example 30

(-)-3-nitrooxymethyl-benzoic acid-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptaren-7-yl ester

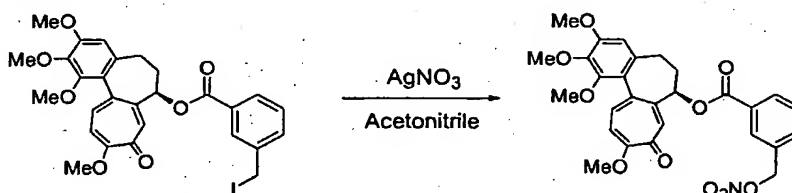


34.4mg of the title compound 30 (81.2%) was prepared by the second step of the Example 4 except for using compound 28 obtained the Example 28.

¹H NMR (500 MHz, CDCl₃): δ 2.10-2.22 (m, 1H), 2.46-2.62 (m, 3H), 3.70 (s, 3H), 3.92 (s, 3H), 3.96 (s, 3H), 3.99 (s, 3H), 5.48 (s, 2H), 5.57 (dd, J = 6.5, 4.5 Hz, 1H), 6.59 (s, 1H), 6.82 (d, J = 10.8 Hz, 1H), 7.32 (d, J = 10.8 Hz, 1H), 7.50 (s, 1H), 7.51 (t, J = 7.8 Hz, 1H), 7.63 (d, J = 7.8 Hz, 1H), 8.09 (s, 1H), 8.10 (d, J = 7.8 Hz, 1H)

Example 31

(+)-3-nitrooxymethyl-benzoic acid-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester



32.5mg of the title compound 31 (76.7%) was prepared by the second step of the Example 4 except for using compound 29 obtained the Example 29.

¹H NMR (500 MHz, CDCl₃): δ 2.10-2.22 (m, 1H), 2.46-2.62 (m, 3H), 3.70 (s, 3H), 3.92 (s, 3H), 3.96 (s, 3H), 3.99 (s, 3H), 5.48 (s, 2H), 5.57 (dd, J = 6.5, 4.5 Hz, 1H), 6.59 (s, 1H), 6.82 (d, J = 10.8 Hz, 1H), 7.32 (d, J = 10.8 Hz, 1H), 7.50 (s, 1H), 7.51 (t, J = 7.8 Hz, 1H), 7.63 (d, J = 7.8 Hz, 1H), 8.09 (s, 1H), 8.10 (d, J = 7.8 Hz, 1H)

Table 1 shows the list of the compounds synthesized in accordance with the method of the present invention in addition to the compounds of the above Examples

Table 1A

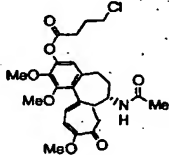
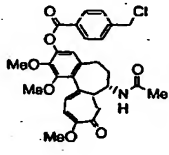
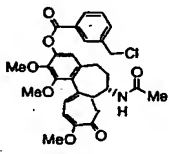
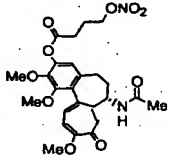
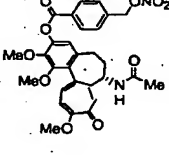
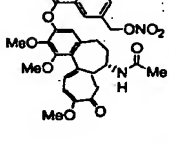
Compounds	¹ H NMR (500 MHz): δ
	1.85-1.90 (m, 1H), 2.00 (s, 3H), 2.23-2.42 (m, 4H), 2.50-2.56 (m, 1H), 2.82-2.88 (m, 2H), 3.68 (s, 3H), 3.74 (t, $J = 6.3$ Hz, 2H), 3.96 (s, 3H), 4.03 (s, 3H), 4.62-4.66 (m, 1H), 6.71 (s, 1H), 6.88 (d, $J = 10.9$ Hz, 1H), 7.34 (d, $J = 10.9$ Hz, 1H), 7.38 (d, $J = 6.3$ Hz, 1H), 7.54 (s, 1H)
	1.92-1.98 (m, 1H), 2.00 (s, 3H), 2.31-2.44 (m, 2H), 2.55-2.59 (m, 1H), 3.69 (s, 3H), 3.94 (s, 3H), 4.03 (s, 3H), 4.64-4.69 (m, 1H), 4.67 (s, 2H), 6.83 (s, 1H), 6.91 (d, $J = 10.9$ Hz, 1H), 7.38 (d, $J = 10.9$ Hz, 1H), 7.57 (d, $J = 8.2$ Hz, 2H), 7.61 (s, 1H), 7.94 (d, $J = 6.2$ Hz, 1H), 8.23 (d, $J = 8.2$ Hz, 2H)
	1.92-2.00 (m, 1H), 1.95 (s, 3H), 2.31-2.44 (m, 2H), 2.57-2.59 (m, 1H), 3.70 (s, 3H), 3.95 (s, 3H), 4.04 (s, 3H), 4.65-4.70 (m, 1H), 4.69 (s, 2H), 6.83 (s, 1H), 6.92 (d, $J = 10.9$ Hz, 1H), 7.39 (d, $J = 10.9$ Hz, 1H), 7.56 (t, $J = 7.6$ Hz, 1H), 7.64 (s, 1H), 7.71 (d, $J = 7.6$ Hz, 1H), 8.03 (d, $J = 6.2$ Hz, 1H), 8.19 (d, $J = 7.6$ Hz, 1H), 8.26 (s, 1H)
	1.91-1.96 (m, 1H), 1.97 (s, 3H), 2.20-2.26 (m, 2H), 2.29-2.40 (m, 2H), 2.52-2.56 (m, 1H), 2.77-2.80 (m, 2H), 3.66 (s, 3H), 3.93 (s, 3H), 4.03 (s, 3H), 4.61-4.65 (m, 1H), 4.64 (t, $J = 6.5$ Hz, 2H), 6.70 (s, 1H), 6.90 (d, $J = 10.9$ Hz, 1H), 7.35 (d, $J = 10.9$ Hz, 1H), 7.60 (s, 1H), 8.05 (d, $J = 6.2$ Hz, 1H)
	1.90-1.95 (m, 1H), 1.99 (s, 3H), 2.29-2.43 (m, 2H), 2.55-2.58 (m, 1H), 3.69 (s, 3H), 3.93 (s, 3H), 4.03 (s, 3H), 4.64-4.68 (m, 1H), 4.82 (s, 2H), 6.83 (s, 1H), 6.91 (d, $J = 10.9$ Hz, 1H), 7.38 (d, $J = 10.9$ Hz, 1H), 7.53 (d, $J = 8.2$ Hz, 2H), 7.60 (s, 1H), 7.91 (d, $J = 6.2$ Hz, 1H), 8.22 (d, $J = 8.2$ Hz, 2H)
	1.89-1.96 (m, 1H), 1.99 (s, 3H), 2.29-2.43 (m, 2H), 2.54-2.58 (m, 1H), 3.69 (s, 3H), 3.93 (s, 3H), 4.03 (s, 3H), 4.63-4.68 (m, 1H), 4.81 (s, 2H), 6.82 (s, 1H), 6.91 (d, $J = 10.9$ Hz, 1H), 7.38 (d, $J = 10.9$ Hz, 1H), 7.53 (t, $J = 7.6$ Hz, 1H), 7.59 (s, 1H), 7.68 (d, $J = 7.6$ Hz, 1H), 7.84 (d, $J = 6.2$ Hz, 1H), 8.15 (d, $J = 7.6$ Hz, 1H), 8.23 (s, 1H)

Table 1B(continued)

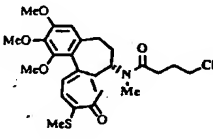
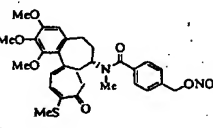
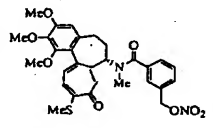
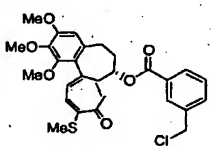
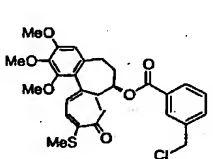
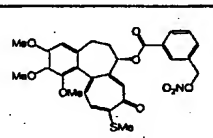
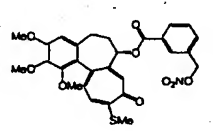
Compounds	¹ H NMR (500 MHz): δ
	1.99-2.06 (m, 2H), 2.08-2.15 (m, 1H), 2.22-2.28 (m, 1H), 2.42 (s, 3H), 2.43-2.51 (m, 3H), 2.61-2.65 (m, 1H), 3.28 (s, 3H), 3.56 (t, $J = 6.0$ Hz, 2H), 3.70 (s, 3H), 3.90 (s, 3H), 3.94 (s, 3H), 4.98 (q, $J = 6.2$, 1H), 6.53 (s, 1H), 6.90 (s, 1H), 7.02 (d, $J = 10.3$ Hz, 1H), 7.27 (d, $J = 10.3$ Hz, 1H)
	2.25-2.36 (m, 2H), 2.44 (s, 3H), 2.49-2.56 (m, 1H), 2.66-2.69 (m, 1H), 3.23 (s, 3H), 3.72 (s, 3H), 3.91 (s, 3H), 3.94 (s, 3H), 5.06 (br, 1H), 5.42 (s, 2H), 6.57 (s, 1H), 7.05 (d, $J = 10.3$ Hz, 1H), 7.08 (s, 1H), 7.31-7.40 (m, 5H)
	2.25-2.37 (m, 2H), 2.44 (s, 3H), 2.48-2.56 (m, 1H), 2.66-2.68 (m, 1H), 3.24 (s, 3H), 3.72 (s, 3H), 3.91 (s, 3H), 3.94 (s, 3H), 5.05 (br, 1H), 5.40 (s, 2H), 6.57 (s, 1H), 7.06 (d, $J = 10.3$ Hz, 1H), 7.09 (s, 1H), 7.31-7.42 (m, 5H)
	2.15-2.20 (m, 1H), 2.43 (s, 3H), 2.44-2.64 (m, 3H), 3.70 (s, 3H), 3.92 (s, 3H), 3.96 (s, 3H), 4.62 (s, 2H), 5.57 (dd, $J = 7, 7.5$ Hz, 1H), 6.59 (s, 1H), 7.05 (d, $J = 10.0$ Hz, 1H), 7.30 (d, $J = 10.0$ Hz, 1H), 7.33 (s, 1H), 7.46 (dd, $J = 8.0, 8.0$ Hz, 1H), 7.62 (d, $J = 8.0$ Hz, 1H), 8.03 (d, $J = 8.0$ Hz, 1H), 8.06 (s, 1H)
	2.15-2.20 (m, 1H), 2.43 (s, 3H), 2.44-2.64 (m, 3H), 3.70 (s, 3H), 3.92 (s, 3H), 3.96 (s, 3H), 4.62 (s, 2H), 5.57 (dd, $J = 7, 7.5$ Hz, 1H), 6.59 (s, 1H), 7.05 (d, $J = 10.0$ Hz, 1H), 7.30 (d, $J = 10.0$ Hz, 1H), 7.33 (s, 1H), 7.46 (dd, $J = 8.0, 8.0$ Hz, 1H), 7.62 (d, $J = 8.0$ Hz, 1H), 8.03 (d, $J = 8.0$ Hz, 1H), 8.06 (s, 1H)
	2.15-2.20 (m, 1H), 2.43 (s, 3H), 2.44-2.64 (m, 3H), 3.70 (s, 3H), 3.92 (s, 3H), 3.96 (s, 3H), 5.48 (s, 2H), 5.57 (dd, $J = 7, 7.5$ Hz, 1H), 6.59 (s, 1H), 7.05 (d, $J = 10.0$ Hz, 1H), 7.30-7.33 (m, 2H), 7.46 (dd, $J = 8.0, 8.0$ Hz, 1H), 7.63 (d, $J = 8.0$ Hz, 1H), 8.08-8.10 (m, 2H)
	2.15-2.20 (m, 1H), 2.43 (s, 3H), 2.44-2.64 (m, 3H), 3.70 (s, 3H), 3.92 (s, 3H), 3.96 (s, 3H), 5.48 (s, 2H), 5.57 (dd, $J = 7, 7.5$ Hz, 1H), 6.59 (s, 1H), 7.05 (d, $J = 10.0$ Hz, 1H), 7.30-7.33 (m, 2H), 7.46 (dd, $J = 8.0, 8.0$ Hz, 1H), 7.63 (d, $J = 8.0$ Hz, 1H), 8.08-8.10 (m, 2H)

Table 1C(continued)

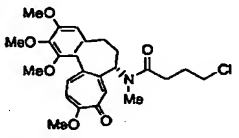
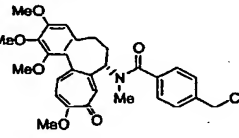
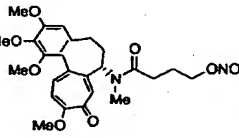
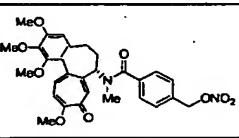
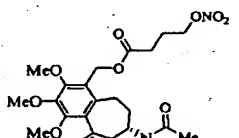
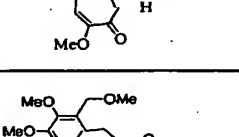
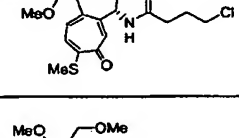
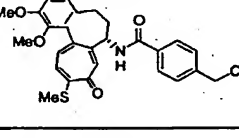
Compounds	¹ H NMR (500 MHz): δ
	2.01-2.40 (m, 4H), 2.43-2.64 (m, 4H), 3.28 (s, 3H), 3.56 (t, $J = 6.0$ Hz, 2H), 3.69 (s, 3H), 3.90 (s, 3H), 3.94 (s, 3H), 3.98 (s, 3H), 4.94-5.01 (m, 1H), 6.53 (s, 1H), 6.80 (d, $J = 10.6$ Hz, 1H), 7.09 (s, 1H), 7.28 (d, $J = 10.6$ Hz, 1H)
	2.20-2.31 (m, 2H), 2.46-2.53 (m, 1H), 2.60-2.65 (m, 1H), 3.22 (s, 3H), 3.70 (s, 3H), 3.84 (s, 3H), 3.86 (s, 3H), 3.97 (s, 3H), 4.55 (s, 2H), 5.01-5.03 (m, 1H), 6.54 (s, 1H), 6.79 (d, $J = 10.6$ Hz, 1H), 7.25-7.45 (m, 6H)
	1.96-2.30 (m, 4H), 2.40-2.67 (m, 4H), 3.26 (s, 3H), 3.69 (s, 3H), 3.90 (s, 3H), 3.94 (s, 3H), 3.98 (s, 3H), 4.45 (t, $J = 6.0$ Hz, 2H), 5.01-5.04 (m, 1H), 6.53 (s, 1H), 6.81 (d, $J = 10.6$ Hz, 1H), 7.07 (s, 1H), 7.28 (d, $J = 10.6$ Hz, 1H)
	2.17-2.39 (m, 2H), 2.51-2.69 (m, 2H), 3.24 (s, 3H), 3.71 (s, 3H), 3.91 (s, 3H), 3.94 (s, 3H), 4.00 (s, 3H), 5.00-5.10 (m, 1H), 5.42 (s, 2H), 6.57 (s, 1H), 6.82 (d, $J = 10.6$ Hz, 1H), 7.28-7.39 (m, 6H)
	1.87-1.96 (m, 1H), 2.03 (s, 3H), 2.05-2.12 (m, 2H), 2.20-2.51 (m, 2H), 2.49 (t, $J = 7.0$ Hz, 2H), 2.81-2.83 (m, 1H), 3.65 (s, 3H), 3.96 (s, 3H), 3.97 (s, 3H), 4.02 (s, 3H), 4.54 (t, $J = 7.0$ Hz, 2H), 4.63-4.65 (m, 1H), 5.17 (d, $J = 12.0$ Hz, 1H), 5.29 (d, $J = 12.0$ Hz, 1H), 6.88 (d, $J = 11.0$ Hz, 1H), 7.28 (d, $J = 11.0$ Hz, 1H), 7.56 (s, 1H), 7.87 (d, $J = 6.5$ Hz, 1H)
	1.82-1.88 (m, 1H), 2.00-2.26 (m, 4H), 2.36-2.56 (m, 2H), 2.45 (s, 3H), 2.91-2.94 (m, 1H), 3.42 (s, 3H), 3.54 (t, $J = 6.2$ Hz, 2H), 3.64 (s, 3H), 3.95 (s, 3H), 3.97 (s, 3H), 4.46 (d, $J = 10.3$ Hz, 1H), 4.50 (d, $J = 10.3$ Hz, 1H), 4.61-4.66 (m, 1H), 7.08 (d, $J = 10.6$ Hz, 1H), 7.25 (d, $J = 10.6$ Hz, 1H), 7.41 (d, $J = 7.3$ Hz, 1H), 7.43 (s, 1H)
	2.05-2.34 (m, 3H), 2.45 (s, 3H), 2.96-3.00 (m, 1H), 3.42 (s, 3H), 3.72 (s, 3H), 3.96 (s, 3H), 3.99 (s, 3H), 4.45 (s, 2H), 4.47 (d, $J = 10.3$ Hz, 1H), 4.54 (d, $J = 10.3$ Hz, 1H), 4.85-4.93 (m, 1H), 7.09 (d, $J = 10.6$ Hz, 1H), 7.22 (d, $J = 8.3$ Hz, 2H), 7.29 (d, $J = 10.3$ Hz, 1H), 7.59 (s, 1H), 7.84 (d, $J = 8.3$ Hz, 2H), 8.34 (d, $J = 7.3$ Hz, 1H)
	1.78-1.85 (m, 1H), 1.98-2.05 (m, 2H), 2.14-2.42 (m, 4H), 2.45 (s, 3H), 2.91-2.94 (m, 1H), 3.42 (s, 3H), 3.64 (s, 3H), 3.95 (s, 3H), 3.97 (s, 3H), 4.42-4.52 (m, 4H), 4.63-4.67 (m, 1H), 7.09 (d, $J = 10.6$ Hz, 1H), 7.26 (d, $J = 10.6$ Hz, 1H), 7.47 (s, 1H), 7.77 (d, $J = 7.3$ Hz, 1H)

Table 1D(continued)

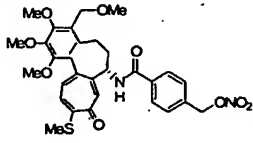
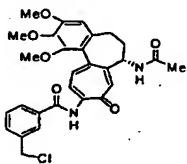
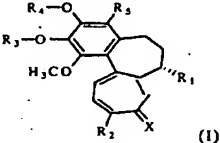
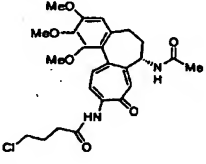
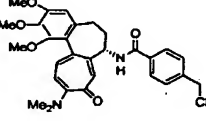
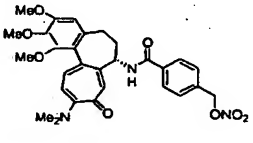
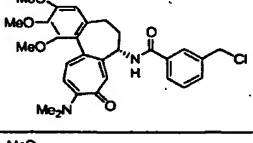
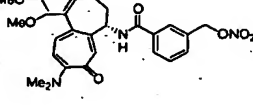
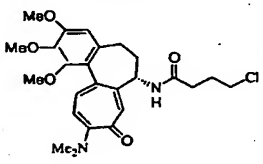
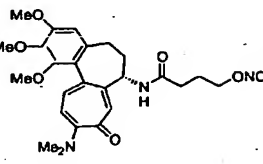
Compounds	¹ H NMR (500 MHz): δ
	2.14-2.34 (m, 3H), 2.45 (s, 3H), 2.96-3.01 (m, 1H), 3.42 (s, 3H), 3.72 (s, 3H), 3.96 (s, 3H), 3.99 (s, 3H), 4.46 (d, $J = 10.3$ Hz, 1H), 4.53 (d, $J = 10.3$ Hz, 1H), 4.88-4.94 (m, 1H), 5.30 (s, 2H), 7.11 (d, $J = 10.6$ Hz, 1H), 7.21 (d, $J = 8.3$ Hz, 2H), 7.31 (d, $J = 10.3$ Hz, 1H), 7.62 (s, 1H), 7.88 (d, $J = 8.3$ Hz, 2H), 8.51 (d, $J = 7.3$ Hz, 1H)
	1.82(m, 1H), 2.03(s, 3H), 2.25(m, 1H), 2.40(m, 1H), 2.54(m, 1H), 3.66(s, 3H), 3.91(s, 3H), 3.94(s, 3H), 4.68(s, 2H), 4.71(m, 1H), 6.54(s, 1H), 6.73(d, $J=7.0$ Hz, 1H), 7.51-7.65(m, 4H), 7.94(d, $J=8.0$ Hz, 1H), 8.01(s, 1H), 9.20(d, $J=11.0$ Hz, 1H), 10.32(s, 1H)
	1.84(m, 1H), 2.03(s, 3H), 2.28(m, 1H), 2.42(m, 1H), 2.54(m, 1H), 3.67(s, 3H), 3.91(s, 3H), 3.92(s, 3H), 4.69(m, 1H), 5.53(s, 2H), 6.39(d, $J=7.0$ Hz, 1H), 6.54(s, 1H), 7.51-7.65(m, 4H), 8.01(d, $J=9.5$ Hz, 1H), 8.03(s, 1H), 9.18(d, $J=11.0$ Hz, 1H), 10.32(s, 1H)
	1.80(m, 1H), 2.02(s, 3H), 2.22(t, $J=6.0, 6.5$ Hz, 2H), 2.40(m, 1H), 2.48(m, 1H), 2.72(t, $J=7.0$ Hz, 2H), 3.62(s, 3H), 3.67(t, $J=6.0$ Hz, 2H), 3.90(s, 3H), 3.94(s, 3H), 4.64(m, 1H), 6.18(d, $J=7.0$ Hz, 1H), 6.52(s, 1H), 7.43(d, $J=10.5$ Hz, 1H), 7.49(s, 1H), 8.99(d, $J=11.0$ Hz, 1H), 9.41(s, 1H)
	1.98(m, 1H), 2.25(m, 1H), 2.47(m, 1H), 2.49(m, 1H), 3.15(s, 3H), 3.71(s, 3H), 3.88(s, 3H), 3.95(s, 3H), 4.55(s, 2H), 4.81(m, 1H), 6.51(s, 1H), 6.55(d, $J=11.5$ Hz, 1H), 7.22(s, 1H), 7.28-7.37(dd, $J=8.5, 11.5$ Hz, 4H), 7.61(d, $J=7.0$ Hz, 1H), 7.87(d, $J=10.5$ Hz, 1H)
	1.98(m, 1H), 2.29(m, 1H), 2.50(m, 1H), 2.51(m, 1H), 3.14(s, 6H), 3.71(s, 3H), 3.89(s, 3H), 3.95(s, 3H), 4.81(m, 1H), 5.42(s, 2H), 6.52(s, 1H), 6.55(d, $J=11.5$ Hz, 1H), 7.17(s, 1H), 7.27-7.40(dd, $J=8.5, 11.5$ Hz, 4H), 7.871(d, $J=8.5$ Hz, 1H)
	1.98(m, 1H), 2.03(m, 1H), 2.48(m, 1H), 2.53(m, 1H), 3.14(s, 6H), 3.70(s, 3H), 3.90(s, 3H), 3.95(s, 3H), 4.56(s, 2H), 4.83(m, 1H), 6.55(s, 1H), 6.56(d, $J=11.2$ Hz, 1H), 6.93(d, $J=7.5$ Hz, 1H), 7.14-7.52(m, 4H), 7.73(d, $J=7.7$ Hz, 1H), 7.79(s, 1H)
	2.20(m, 1H), 2.48(m, 1H), 2.54(m, 2H), 3.15(s, 6H), 3.72(s, 3H), 3.90(s, 3H), 3.96(s, 3H), 4.85(m, 1H), 5.32(d, $J=5.3$ Hz, 2H), 6.55(s, 1H), 6.58(d, $J=11.3$ Hz, 1H), 7.28-7.54(m, 4H), 7.76(d, $J=7.8$ Hz, 1H), 7.80(s, 1H)

Table 1E(continued)

Compounds	¹ H NMR (500 MHz): δ
	1.80(m, 1H), 2.04(m, 1H), 2.07(t, 2H, $J=7.0$ Hz), 2.20(m, 1H), 2.43 (m, 1H), 2.49(t, $J=7.0$ Hz, 2H), 3.17(s, 6H), 3.56(t, $J=6.0, 6.5$ Hz, 2H), 3.64(s, 3H), 3.87(s, 3H), 3.93(s, 3H), 4.60(m, 1H), 6.49(s, 1H), 6.55(d, $J=11.5$ Hz, 1H), 7.16(s, 1H), 7.21(d, $J=10.5$ Hz, 1H), 7.27(d, $J=11.5$ Hz, 1H)
	2.01(m, 1H), 2.04(t, 2H, $J=6.5, 6.5$ Hz), 2.18(m, 1H), 2.40(m, 1H), 2.46(m, 2H), 2.48(m, 1H), 3.17(s, 6H), 3.64(s, 3H), 3.88(s, 3H), 3.93(s, 3H), 4.45(t, 2H, $J=6.0, 6.5$ Hz), 4.58(m, 1H), 6.48(s, 1H), 6.55(d, 1H, $J=11.5$ Hz), 7.11(s, 1H), 7.27(d, 1H, $J=11.5$ Hz), 7.44(d, 1H, $J=7.0$ Hz)

5 Example A: Anticancer effect test

To ascertain the anticancer effects of colchicine derivatives of the formula (I) according to the present invention, the following tests were carried out by sulforhodamine-B (SRB) cytotoxicity assay. For comparison of anticancer effects, conventional colchicine and taxol as an anticancer drug were used as control groups.

10 Human tumor cells, including MCF-7 (human breast adenomatous tumor), MCF-7/DOX (adriamycin resistant cell strain), MRS-SA (human uterine sarcoma), MES-SA/DX5 (adriamycin resistant cell strain), A 549 (human non-small cell lung), SKOV-3 (human ovarian), SKMEL-2 (human melanoma), XF-498 (human CNS), HCT-15 (human colon) were incubated at 37°C in the presence of 5% CO₂ using a
 15 DMEM culture medium. The respective cells were seeded into each well of 96-well plates at a concentration of $2 \times 10^3 \sim 5 \times 10^3$ cells/well. After culturing for 24 hours, colchicine dissolved in dimethylsulfoxide (DMSO), a compound 6, a compound 12 and taxol were diluted, and further cultured for 72 hours. Each cell line of the
 20 resultant plates was fixed with trichloroacetic acid (TCA), stained with 0.4% SRB solution and rinsed with 1% acetic acid. Thereafter, the dye was dissolved in 10mM Tris base to measure the optical density (OD) at 520 nm. The measurement results are listed in Tables 2 and 3.

Table 2

Materials	ED50 (nM)			
	MCF7	MCF-7/DOX	MES-SA	MES-SA/DX5
Colchicine	4	183	16	961
Compound 6	0.02	205	0.2	773
Compound 12	0.02	28	0.01	115
Taxol	0.04	943	0.02	1147

Table 3

Material	ED50 (nM)				
	A549	SK-OV-3	SK-MEL-2	XF498	HCT15
Colchicine	9	8	3	4	3
Compound 6	0.1	0.2	0.1	0.1	0.1
Compound 12	0.1	0.3	0.1	0.2	0.1
Taxol	0.3	1.2	0.1	1.7	0.1

5 When ED50 values of the compounds 6 and 12 were investigated for each cell line, the colchicine derivative of the present invention exhibited a higher anticancer effect even at a low concentration of 0.02 to 773 nM than the conventional colchicine and taxol as shown in Tables 2 and 3.

Example B: Mixed lymphocyte reaction (MLR) tests

10 MLR tests were carried out to determine the immunosuppressive effect of an immunosuppressive candidate material. When a responding cell (BALB/c mouse spleen cell) and a stimulating cell (DBA/2 mouse spleen cell) were cultured separately, the cells grew little. On the contrary, when the cells were simultaneously cultured, the cells were proliferated due to induction of an antigen-antibody reaction. The
15 proliferated cells were treated with the immunosuppressive candidate material for measurement of the proliferation inhibitory extent.

 Responding cells (BALB/c mouse spleen cells) and stimulating cells (DBA/2 mouse spleen cells) were respectively seeded into each well of 96-well plates at a concentration of 2×10^5 cells/well for simultaneous culturing, and cyclosporin A
20 (positive control group), colchicines, and colchicine derivatives of the present invention (compounds 6, 9, 10, 11 and 12) were treated. After culturing for 72 hours at a CO₂ incubator, a 20 μ l MTS solution was added to each well, followed by further culturing for 2 to 4 hours and measuring OD at 490 nm by using ELISA. The

results were shown in FIG. 1.

As shown in FIG. 1, it can be found that the colchicine derivatives according to the present invention, that is, the compounds 6, 9, 10, 11 and 12, suppressed growth of cells even at concentrations as low as 100 to 1000 nm and had a good immunosuppressive effect.

Example C: Immunosuppressive effect test using BALB/c mouse spleen cells

This test was carried out to determine the immunosuppressive effect of an immunosuppressive candidate material by checking anti-proliferation of T cells and B cells. To identify the proliferation inhibitory extent, responding cells (BALB/c mouse spleen cells) were treated with an immunosuppressive candidate material, lipopolysaccharide (LPS) as a B cell activator and concanavalin A (ConA) as a T cell activator. It is known that the responding cells treated with LPS induce proliferation of B cells and those treated with ConA induce proliferation of T cells.

Responding cells (BALB/c mouse spleen cells) were seeded into each well of 96-well plates at a concentration of 2×10^5 cells/well. Then, 20 $\mu\text{g/ml}$ lipopolysaccharide, cyclosporin A (positive control group), and inventive colchicine derivatives (compounds 6, 10 and 12) were simultaneously treated, and 2 $\mu\text{g/ml}$ of ConA, cyclosporin A (positive control sample), and inventive colchicine derivatives (compounds 6, 10 and 12) were simultaneously treated. After culturing for 72 hours at a CO_2 incubator, a 20 μl MTS solution was added to each well, followed by further culturing for 2 to 4 hours and measuring OD at 490 nm using ELISA. The measurement results are shown in FIGS. 2 and 3.

As shown in FIGS. 2 and 3, the colchicine derivatives according to the present invention suppressed proliferation of the B and T cells induced by LPS and ConA, respectively, in a concentration-dependent manner. The immunosuppressive effect of the colchicine derivatives according to the present invention was superior to that of cyclosporin A, a conventional immunosuppressive agent. In particular, the compounds 6 and 12 exhibited a remarkable anti-proliferous effect on B and T cells (FIG. 3).

Example D: Toxicity assay

The colchicine derivatives according to the present invention were

administered to ICR mice of 4-5 weeks old, weighing 18 to 20g, for acute (intravenous administration) toxicity assay and oral administration toxicity assay, as demonstrated in Tables 5 and 7. The same assays were carried out using colchicine as a control group (see Tables 4 and 6).

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Table 4: Acute toxicity of colchicine intravenously administered to mice

Group	Number of Mouse	Dosage (mg/kg)	Days for the test (death)							Total
			1	2	3	4	5	6	7	
T1	5	2	-	3	1	-	-	1	-	5/5
T2	5	5	1	4						5/5
T3	5	10	4	1						5/5

Table 5: Acute toxicity of compound 6 intravenously administered to mice

Group	Number of Mouse	Dosage (mg/kg)	Days for the test (death)							Total
			1	2	3	4	5	6	7	
T1	5	5	-	-	-	-	-	-	-	0/5
T2	5	10	-	-	-	-	-	-	-	0/5
T3	5	25	-	-	-	-	-	-	-	0/2
T4	3	50	3							3/3

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Table 6: Toxicity of colchicine orally administered to mice

Group	Number of Mouse	Dosage (mg/kg)	Days for the Test (death)							Total
			1	2	3	4	5	6	7	
T1	5	5	-	-	-	-	-	-	-	0/5
T2	5	10	-	-	-	-	-	-	-	0/5
T3	5	25	-	-	3	1	-	-	-	4/5
T4	3	50	-	3	-	1	1	-	-	5/5

Table 7: Toxicity of compound 6 orally administered to mice

Group	Number of Mouse	Dosage (mg/kg)	Days for the Test (Death)							Total
			1	2	3	4	5	6	7	
T1	5	2	-	-	-	-	-	-	-	0/5
T2	5	5	-	-	-	1	-	-	-	1/5
T3	5	10	-	1	1	-	-	-	-	2/5

Example E: Reverse mutation assay by using bacteria

This assay is carried out to test mutagenicity of chemical substances using histidine auxotrophic strains that are one of *Salmonella Typhimurium* mutants. In the assay, artificially induced mutants (histidine auxotrophic mutants) are cultured in a histidine-free culture medium. When various mutagens are added to the culture medium, only revertants generated by reverse mutation survive. Thus generated colonies and spontaneously induced revertants are compared for detection of mutation.

Ames test was carried out using WP2 uvrA strains (tryptophan auxotrophic strains) of TA100, TA1535, TA98, TA1537 and *Escherichia coli*. Mutagens used as positive control samples were 0.5 $\mu\text{g}/\text{plate}$ of sodium azide, 0.5 $\mu\text{g}/\text{plate}$ of 4NQO (4-nitroquinolin-1-oxide), 50 $\mu\text{g}/\text{plate}$ of 9-AA (9-aminoacridine). Colchicine and colchicine derivative (Compound 6) according to the present invention were treated at amounts of 0, 317.5, 625, 1250, 2500 and 5000 $\mu\text{g}/\text{plate}$, and incubated in the presence (+) and absence (-) of microsomal polysubstrate oxygenases (S-9 mixture) at 37°C for 48 hours. After incubation, the number of revertant colonies was counted. 3 plates were prepared for each test and the average was calculated. The results are demonstrated in Tables 8 and 9.

Table 8

Test Strain	Material	Dosage ($\mu\text{g}/\text{Plate}$)	Colony/Plate	
			S-9 Mixture (-)	S-9 Mixture (+)
TA100	Colchicine	0	121	103
		317.5	115	79
		625	110	76
		1250	112	100
		2500	115	91
		5000	108	78
TA1525	Colchicine	0	14	13
		317.5	18	13
		625	15	13
		1250	17	7
		2500	17	12
		5000	13	10

TA98		Colchicine	0 317.5 625 1250 2500 5000	31 29 29 29 24 26	35 37 32 33 37 28
TA1537		Colchicine	0 317.5 625 1250 2500 5000	10 17 14 10 8 9	14 20 18 18 21 21
<i>E. coli</i> WP2 uvrA		Colchicine	0 317.5 625 1250 2500 5000	11 10 6 11 10 11	10 11 14 14 12 8
Positive control group	TA100	Sodium azide	0.5	453	616
	TA1535	Sodium azide	0.5	279	444
	TA98	4NQO	0.5	488	391
	TA1537	9-AA	50	175	588
	WP2 uvrA	4NQO	0.5	268	653

Table 9

Test Strain	Materials	Dosage (μ g/plate)	Colony/plate	
			S-9 Mixture (-)	S-9 Mixture (+)
TA100	Compound 6	0	95	104
		317.5	81	96
		625	77	84
		1250	84	81
		2500	88	77
		5000	79	78
TA1525	Compound 6	0	12	10
		317.5	14	14
		625	18	12
		1250	15	11
		2500	10	11
		5000	13	9

TA98		Compound 6	0	28	36
			317.5	21	32
			625	32	29
			1250	24	33
			2500	22	22
			5000	19	23
TA1537		Compound 6	0	10	15
			317.5	8	11
			625	10	16
			1250	16	13
			2500	11	17
			5000	7	14
<i>E.coli</i> WP2 uvrA		Compound 6	0	11	10
			317.5	16	12
			625	9	12
			1250	10	12
			2500	8	9
			5000	11	13
Positive Control group	TA100	Sodium azide	0.5	453	616
	TA1535	Sodium azide	0.5	279	444
	TA98	4NQO	0.5	488	391
	TA1537	9-AA	50	175	588
	WP2 uvrA	4NQO	0.5	268	653

As shown in Tables 8 and 9, the colchicine derivatives according to the present invention induced noticeably fewer revertant colonies than the positive control groups, implying no significant hazard as mutagens.

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Industrial Applicability

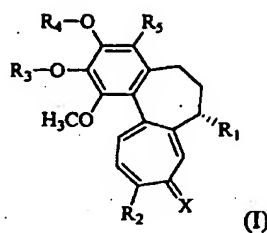
As described above, the novel colchicine derivative of the formula (I) according to the present invention or pharmaceutically acceptable salts thereof are superior to conventional colchicine in view of anticancer, anti-proliferous and immunosuppressive effects, and have less likelihood of toxicity and less hazard as mutagen than conventional colchicine.

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What claimed is:

1. Colchicine derivative of the following formula (I) and pharmaceutically acceptable salts thereof:

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wherein:

when R_1 is $N(R_6)C(X_1)-A$, $X_2C(X_1)-A$, $N(R_6)-A$, $N(A)_2$ or X_2-A , R_2 is X_3R_7 or $N(R_7)_2$, R_3 and R_4 are independently hydrogen or a methyl group, R_5 is hydrogen, a methyl group, or $CH_2X_4R_7$, wherein R_6 and R_7 are independently hydrogen or a lower alkyl group, and X , X_1 , X_2 , X_3 and X_4 are independently O or S;

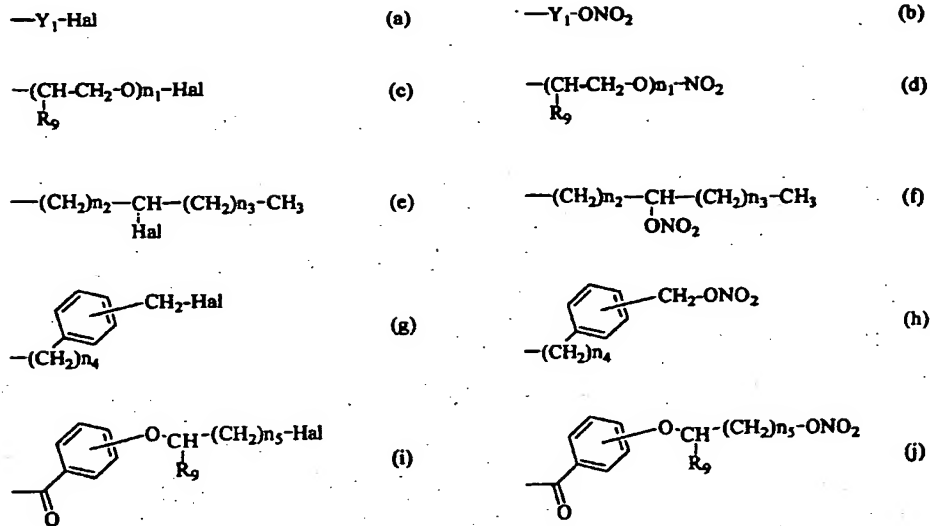
when R_2 is $N(R_6)C(X_1)-A$, $X_2C(X_1)-A$, $N(R_6)-A$, $N(A)_2$ or X_2-A , R_1 is $N(R_6)COCH_3$, $N(R_6)COCF_3$, or $NHC(O)OR_8$, R_3 and R_4 are independently hydrogen or a methyl group, R_5 is hydrogen, a methyl group, or $CH_2X_4R_7$, wherein R_6 and R_7 are independently hydrogen or a lower alkyl group, R_8 is a lower alkyl, alkenyl, or substituted or unsubstituted aryl, and X , X_1 , X_2 and X_4 are independently O or S;

when R_3 and R_4 are independently $C(X_1)-A$ or $-A$, R_1 is $N(R_6)COCH_3$, $N(R_6)COCF_3$, or $NHC(O)OR_8$, R_2 is X_3R_7 or $N(R_7)_2$, R_5 is hydrogen, a methyl group, or $CH_2X_4R_7$, wherein R_6 and R_7 are independently hydrogen or a lower alkyl group, R_8 is a lower alkyl, alkenyl, or substituted or unsubstituted aryl, and X , X_1 , X_3 or X_4 are independently O or S;

when R_5 is $CH_2X_2C(X_1)-A$, R_1 is $N(R_6)COCH_3$, $N(R_6)COCF_3$ or $NHC(O)OR_8$, R_2 is X_3R_7 or $N(R_7)_2$, R_3 and R_4 are independently hydrogen or a methyl group, wherein R_6 and R_7 are independently hydrogen or a lower alkyl group, R_8 is a lower alkyl, alkenyl, or substituted or unsubstituted aryl group, and X , X_1 , X_2 and X_3 are

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independently O or S, wherein A is represented by the formula (a), (b), (c), (d), (e), (f), (g), (h), (i) or (j):



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wherein Y_1 is a C_1 to C_{10} straight chain or branched alkyl, preferably, a C_2 to C_5 straight chain or branched alkyl or a substituted C_5 to C_7 cycloalkyl group; Hal is halogen, for example, F, Cl, Br or I; R_9 is hydrogen or a lower alkyl group; n_1 is an integer from 1 to 6, preferably from 2 to 4; n_2 and n_3 are independently an integer from 1 to 5, preferably from 1 to 3; n_4 is an integer from 0 to 3; and n_5 is an integer from 1 to 6.

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2. A compound selected from the group consisting of:

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4-chloro-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide;

4-chloromethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;

3-chloromethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;

- 4-iodo-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide;
- 4-nitrooxy-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide;
- 5 4-iodomethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- 4-nitrooxymethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- 3-iodomethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-
- 10 benzo[a]heptarene-7-yl)-benzamide;
- 3-nitrooxymethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- 4-chloro-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide;
- 15 4-chloromethyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- 3-chloromethyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- 4-iodo-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-
- 20 benzo[a]heptarene-7-yl)-butylamide;
- 4-nitrooxy-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide;
- 4-iodomethyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- 25 4-nitrooxymethyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- 3-iodomethyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- 3-nitrooxymethyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-
- 30 tetrahydro-benzo[a]heptarene-7-yl)-benzamide;

- N-(7-acetylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-10-yl)-4-chloromethyl-benzamide;
- N-(7-acetylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-10-yl)-4-iodomethyl-benzamide;
- 5 N-(7-acetylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-10-yl)-4-nitrooxymethyl-benzamide;
- 4-chloromethyl-benzoic acid 7-acetylamino-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl-methyl ester;
- 4-chloromethyl-benzoic acid 7-acetylamino-1,2,3-trimethoxy-10-methylsulfanyl-10
- 9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl-methyl ester;
- 4-chloro-butyric acid 7-acetylamino-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl-methyl ester;
- 4-chloro-butyric acid 7-acetylamino-1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl-methyl ester;
- 15 4-nitrooxymethyl-benzoic acid 7-acetylamino-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl-methyl ester;
- 4-iodomethyl-butyric acid 7-acetylamino-1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl-methyl ester;
- 4-nitrooxymethyl-butyric acid 7-acetylamino-1,2,3-trimethoxy-10-
- 20 methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl-methyl ester;
- 4-iodomethyl-benzoic acid 7-acetylamino-1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl-methyl ester;
- 4-nitrooxymethyl-benzoic acid 7-acetylamino-1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl-methyl ester;
- 25 (-)-3-chloromethyl-benzoic acid 1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
- (+)-3-chloromethyl-benzoic acid 1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
- (-)-3-iodomethyl-benzoic acid 1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-
- 30 benzo[a]heptarene-7-yl ester;

- (+)-3-iodomethyl-benzoic acid 1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
- (-)-3-nitrooxymethyl-benzoic acid 1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
- 5 (+)-3-nitrooxymethyl-benzoic acid 1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
- 4-chloro-butyric acid 7-acetylamino-1,2,10-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-3-yl ester;
- 4-chloromethyl-benzoic acid 7-acetylamino-1,2,10-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-3-yl ester;
- 10 3-chloromethyl-benzoic acid 7-acetylamino-1,2,10-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-3-yl ester;
- 4-nitrooxy-butyric acid 7-acetylamino-1,2,10-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-3-yl ester;
- 15 4-nitrooxymethyl-benzoic acid 7-acetylamino-1,2,10-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-3-yl ester;
- 3-nitrooxymethyl-benzoic acid 7-acetylamino-1,2,10-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-3-yl ester;
- 4-chloro-N-methyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide;
- 20 4-nitrooxymethyl-N-methyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- 3-nitrooxymethyl-N-methyl-N-(1,2,3-trimethoxy-10-methylsulfanyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- 25 (-)-3-chloromethyl-benzoic acid 1,2,3-trimethoxy-10-methylsulfenyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
- (+)-3-chloromethyl-benzoic acid 1,2,3-trimethoxy-10-methylsulfenyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
- (-)-3-nitrooxymethyl-benzoic acid 1,2,3-trimethoxy-10-methylsulfenyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
- 30 5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;

- (+)-3-nitrooxymethyl-benzoic acid 1,2,3-trimethoxy-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl ester;
- 4-chloro-N-methyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl) butylamide;
- 5 4-chloromethyl-N-methyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl) benzamide;
- N-methyl-4-nitrooxy-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl) butylamide;
- N-methyl-4-nitrooxymethyl-N-(1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo
- 10 [a]heptarene-7-yl) benzamide;
- 4-nitrooxy-butyric acid 7-acetylamino-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-4-yl methyl ester;
- 4-chloro-N-(1,2,3-trimethoxy-4-methoxymethyl-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide;
- 15 4-chloromethyl-N-(1,2,3-trimethoxy-4-methoxymethyl-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- 4-nitrooxy-N-(1,2,3-trimethoxy-4-methoxymethyl-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butylamide;
- 4-nitrooxymethyl-N-(1,2,3-trimethoxy-4-methoxymethyl-10-methylsulfonyl-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- 20 N-(7-acetylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-10-yl)-3-chloromethyl-benzamide;
- N-(7-acetylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-10-yl)-3-nitrooxymethyl-benzamide;
- 25 N-(7-acetylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-10-yl)-4-chloro-butylamide;
- 4-chloromethyl-N-(10-dimethylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;
- N-(10-dimethylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-4-nitrooxymethyl-benzamide;
- 30

3-chloromethyl-N-(10-dimethylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-benzamide;

N-(10-dimethylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-3-nitrooxymethyl-benzamide;

- 5 4-chloro-N-(10-dimethylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-butyramide; and
N-(10-dimethylamino-1,2,3-trimethoxy-9-oxo-5,6,7,9-tetrahydro-benzo[a]heptarene-7-yl)-4-nitrooxy-butyramide,
or pharmaceutically acceptable salts thereof.

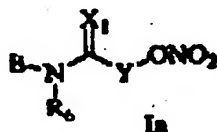
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3. A pharmaceutical composition comprising the colchicine derivative or its pharmaceutically acceptable salt according to claim 1 or 2.

4. An anticancer agent, an anti-proliferous agent, and an immunosuppressive
15 agent comprising the colchicine derivative or its pharmaceutically acceptable salt according to claim 1 or 2 as an active ingredient.

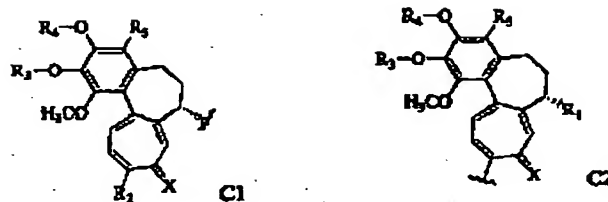
5. A method for preparing a colchicine derivative of the formula (Ia) among the colchicine derivatives according to claim 1 comprising:

- 20 reacting a compound of the formula (II) with a compound of the following formula (III) or a compound of the following formula (V) for amidation to produce a compound of the following formula (IV) or a compound of the following formula (VI); and subjecting the compound of the formula (IV) or (VI) for nitration to convert the same into the colchicine derivative of the formula (Ia):

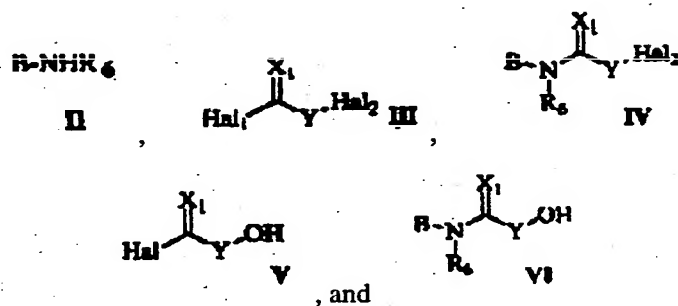


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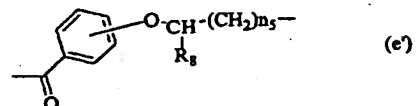
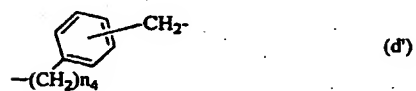
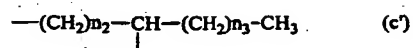
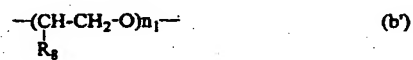
wherein, B is represented by the following formulas C1 and C2:



(wherein R_1 through R_5 and X are defined as in claim 1),

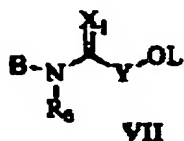


5 wherein R_6 is hydrogen or a lower alkyl group; X_1 is O or S; Hal, Hal₁, and Hal₂ are independently the same or different halogen; and Y is represented by the general formulas (a'), (b'), (c'), (d') or (e'):



wherein Y_1 represents a C_1 to C_{10} straight chain or branched alkyl, preferably, a C_2 to C_5 straight chain or branched alkyl, or a substituted C_5 to C_7 cycloalkyl, R_8 represents hydrogen or a lower alkyl, n_1 is an integer from 1 to 6, preferably from 2 to 4, n_2 and n_3 are independently an integer from 1 to 5, preferably from 1 to 3, n_4 is an integer from 0 to 3, and n_5 is an integer from 1 to 6.

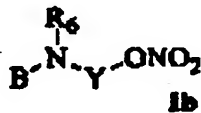
6. The method according to claim 5 comprising nitration of a compound represented by the formula (VII) prepared by converting hydrogen of alcohol in the compound of the formula (VI) into a leaving group before the nitration of the compound of the formula (VI):



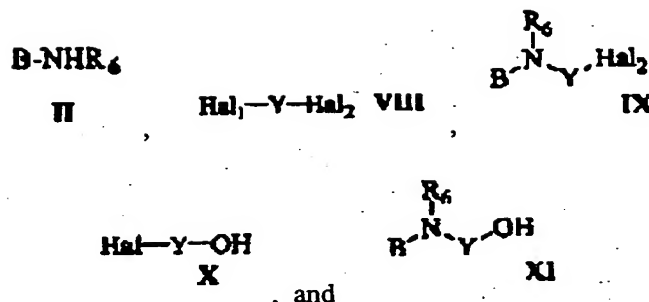
wherein B, R_6 , X_1 and Y are defined as in claim 5, and L is a leaving group selected from a methanesulfonyl, *p*-toluenesulfonyl or triflate.

7. A method for preparing a colchicine derivative of the formula (Ib) among the colchicine derivatives according to claim 1 comprising:

reacting the compound of the formula (II) with a compound of the formula (VIII) or a compound of the formula (X) for amidation to produce a compound (IX) or a compound of the formula (XI); and subjecting the compound of the formula (IX) or the compound of the formula (XI) to nitration for converting the same into the compound of the formula (Ib):

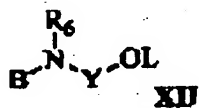


wherein B is defined as in claim 5,



wherein R₆, Y, and Hal are defined as in claim 5; Hal₁ and Hal₂ are independently the same or different halogen.

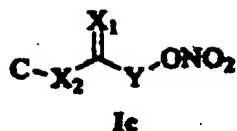
8. The method according to claim 7 comprising nitration of a compound represented by the formula (XII) prepared by converting hydrogen of alcohol in the compound of the formula (XI) into a leaving group before nitration of the compound of the formula (XI):



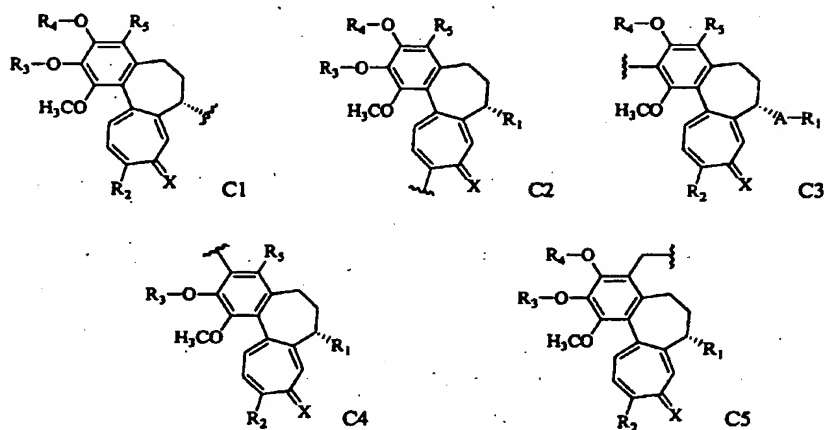
wherein B, R₆, and Y are defined as in claim 7, and L is a leaving group selected from a methanesulfonyl, *p*-toluene sulfonyl or triflate.

9. A method of preparing a colchicine derivative of the formula (Ic) among the colchicine derivatives according to claim 1 comprising:

reacting a compound of the formula (XIII) with a compound of the formula (III) or a compound of the formula (XV) for esterification to produce a compound of the formula (XIV) or a compound of the formula (XVI); and subjecting the compound of the formula (XIV) or the compound of the formula (XVI) to nitration to produce the compound of the formula (Ic):

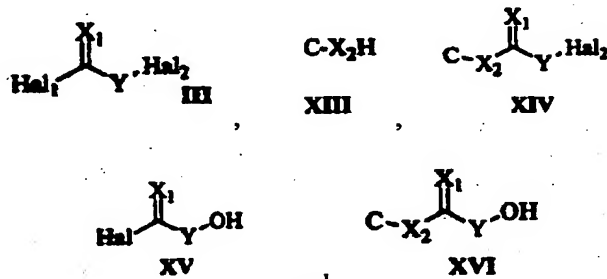


wherein C is represented by the formula C1, C2, C3, C4 or C5:



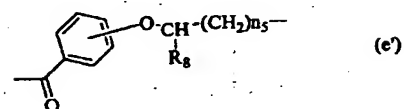
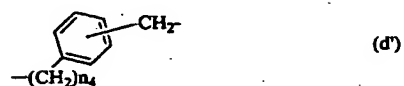
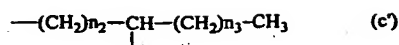
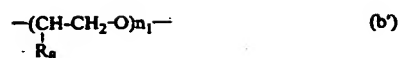
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wherein R₁ through R₅ and X are defined as in claim 1,



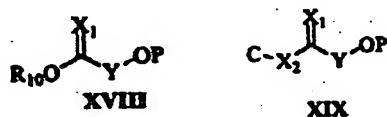
wherein X₁ and X₂ are each independently O or S; Hal is halogen; Hal₁ and Hal₂ are independently the same or different halogen; and Y is represented by the

10 general formulas (a'), (b'), (c'), (d') or (e'):



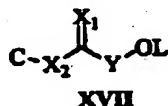
wherein Y_1 represents a C_1 to C_{10} straight chain or branched alkyl, preferably, a C_2 to C_5 straight chain or branched alkyl, or a substituted C_5 to C_7 cycloalkyl, R_8 represents hydrogen or a lower alkyl, n_1 is an integer from 1 to 6, preferably from 2 to 4, n_2 and n_3 are independently an integer from 1 to 5, preferably from 2 to 4, n_4 is an integer 0 to 3, and n_5 is an integer from 1 to 6.

10. The method according to claim 9 comprising reacting the compound of the formula (XIII) with a compound of the formula (XVIII) having a hydroxy-protecting group to produce a compound of the formula (XIX) before esterification of the compound of the formula (XIII); and converting the compound of the formula (XIX) into a compound of the formula (XVI) by a deprotection:



wherein C, X_1 and Y are defined as in claim 9; P represents a general hydroxy-protecting group selected among methoxymethyl or t-butyldimethylsilyl; and R_{10} is hydrogen or a lower alcohol of C_1 to C_3 .

11. The method according to claim 9 or 10 comprising nitration of a compound of the formula (XVII) prepared by converting hydrogen of alcohol in the compound of the formula (XVI) into a leaving group before nitration of the compound of the formula (XVI):

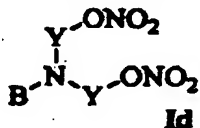


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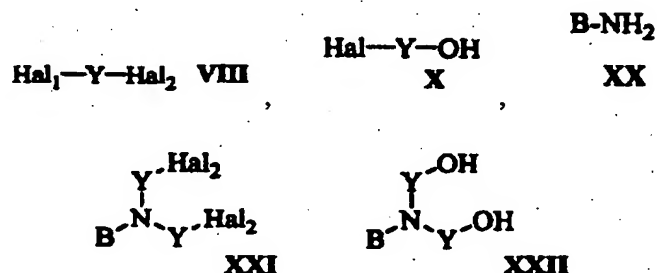
wherein C, X₁, X₂ and Y are defined as in claim 9, and L represents a leaving group selected from methanesulfonyl, *p*-toluene sulfonyl or triflate.

12. A method for preparing a colchicine derivative of the formula (Id) among the colchicine derivatives according to claim 1 comprising:

reacting a compound of the formula (XX) with a compound of the formula (VIII) or a compound of the formula (X) for amidation to produce a compound of the formula (XXI) or a compound of the formula (XXII); and subjecting the compound of the formula (XXI) or the compound of the formula (XXII) to nitration to convert the same into the colchicine derivative of the formula (Id):

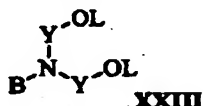


wherein B is defined as in claim 5,



20 wherein Y and Hal is defined as in claim 5; Hal₁ and Hal₂ are independently the same or different halogen.

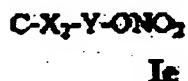
13. The method according to claim 12 comprising nitration of a compound of the formula (XXIII) prepared by converting each hydrogen of alcohols in the compound of the formula (XXII) into a leaving group before nitration of the compound of the formula (XXII):



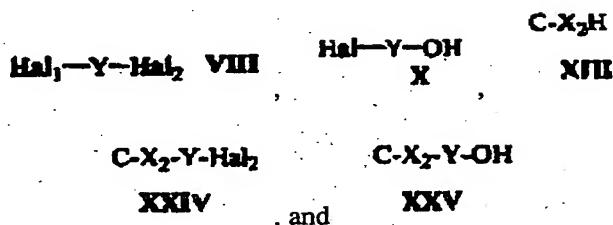
wherein B and Y are defined as in claim 12, and L represents a leaving group selected from methanesulfonyl, *p*-toluene sulfonyl or triflate.

14. A method of preparing a colchicine derivative of the formula (Ic) among the colchicine derivatives according to claim 1 comprising:

reacting a compound of the formula (XIII) with a compound of the formula (VIII) or a compound of the formula (X) for esterification to produce a compound of the formula (XXIV) or a compound of the formula (XXV); and subjecting the compound of the formula (XXIV) or the compound of the formula (XXV) to nitration to convert the same into the colchicine derivative of the formula (Ic):



wherein C is defined as in claim 9,



wherein X₂, Y, Hal, Hal₁ and Hal₂ are defined as in claim 9:

15. The method according to claim 14 comprising nitration of a compound of the formula (XXVI) prepared by converting hydrogen of alcohol in the compound

of the formula (XXV) into a leaving group before nitration of the compound of the formula (XXV):

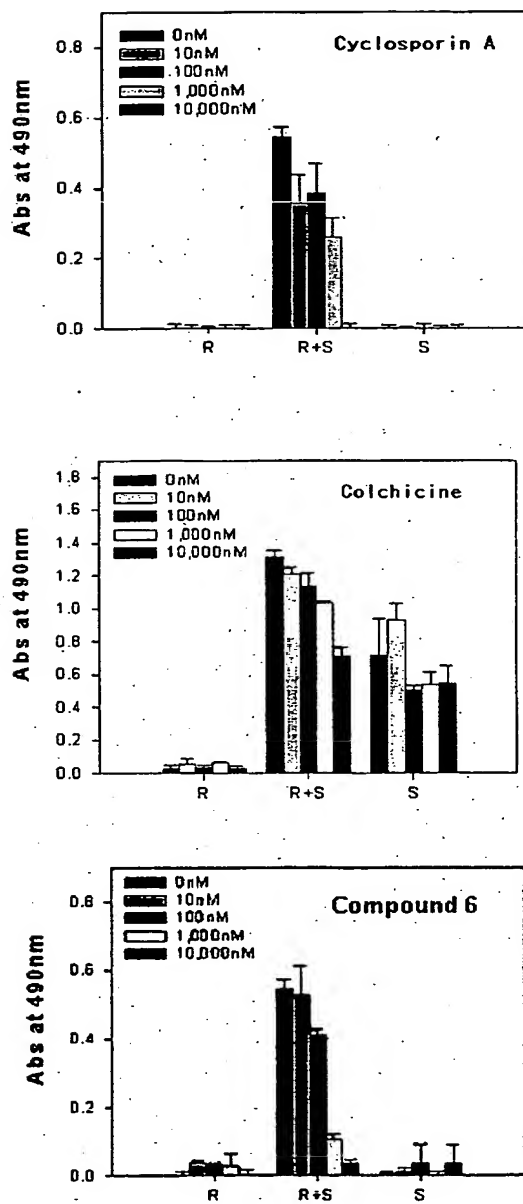


XXVI

wherein C, X₂ and Y are defined as in claim 14, and L represents a leaving
5 group selected from methanesulfonyl, *p*-toluene sulfonyl or triflate.

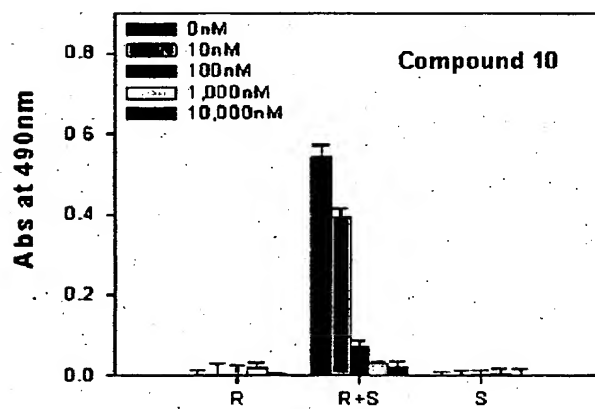
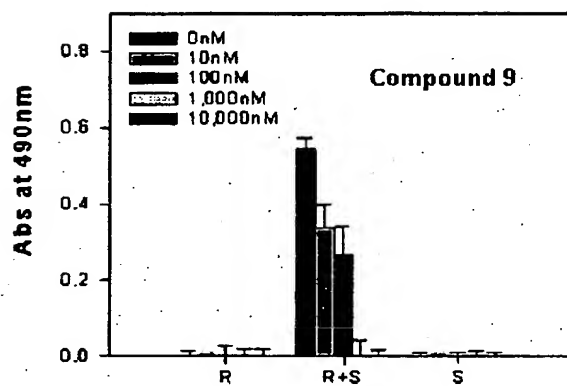
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FIG. 1



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FIG. 1(Continued)



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FIG. 1(Continued)

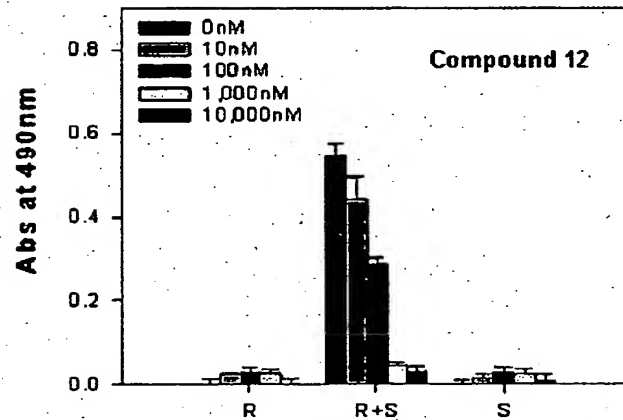
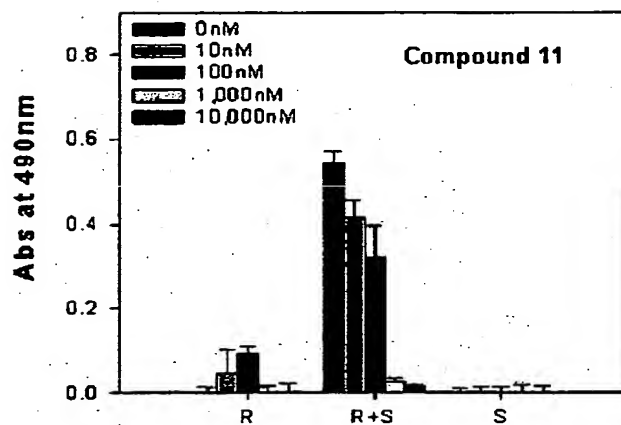
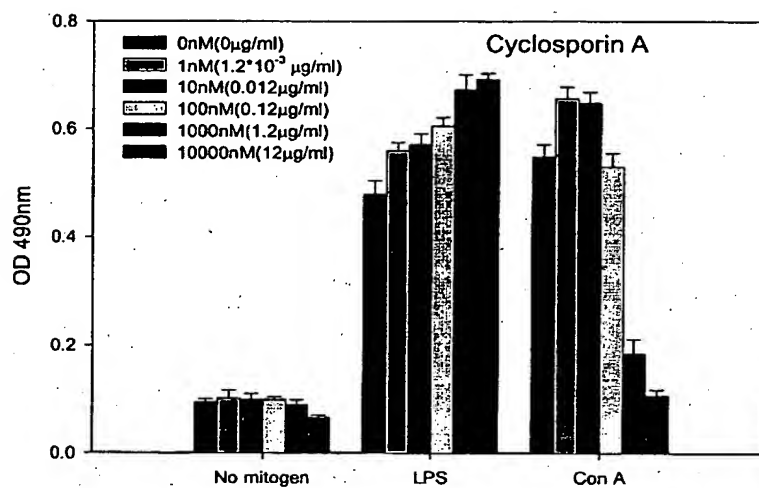
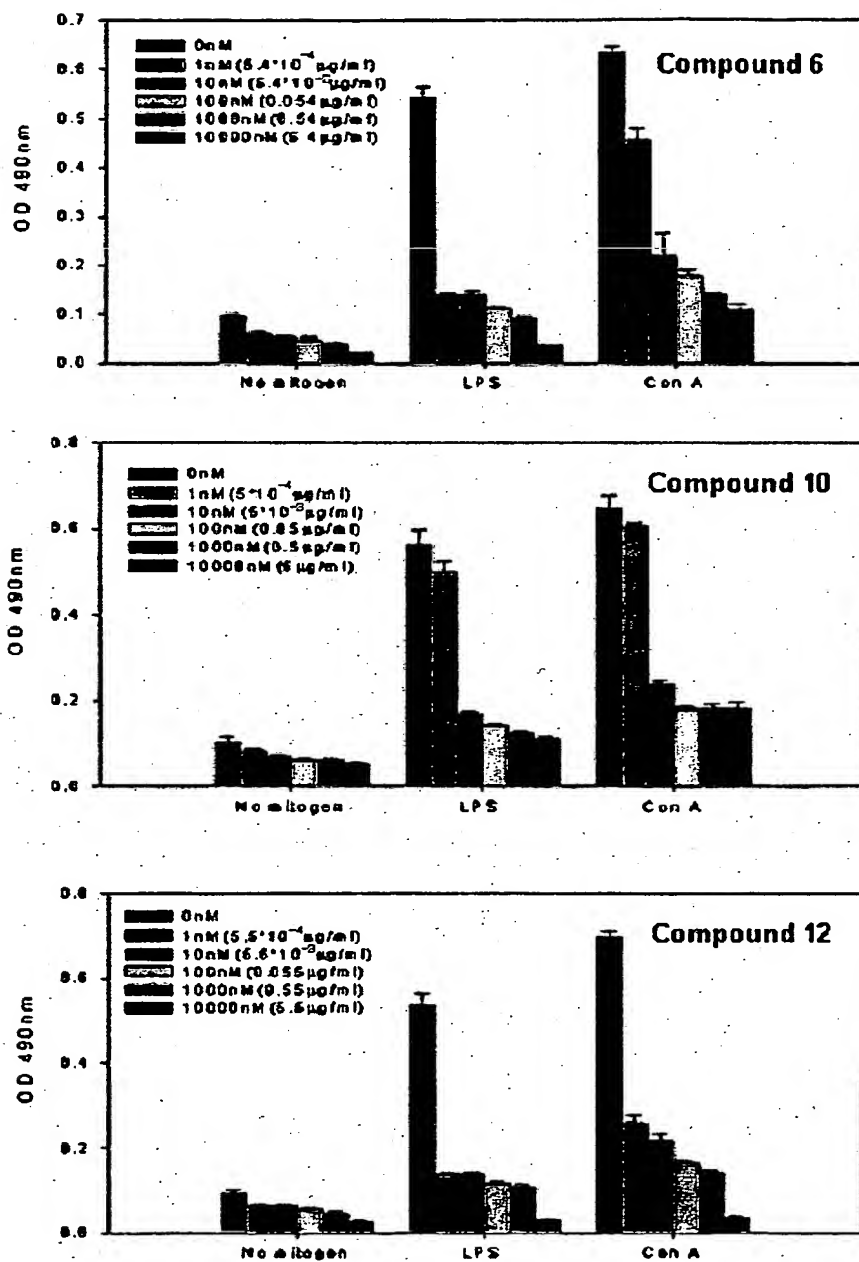


FIG. 2



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FIG. 3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR02/00996

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 C07C 323/41

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7 C07C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Patents and applications for inventions since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Cas On line

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Journal of Medicinal Chemistry, 40(6), pp.961-966, (Shi, Qian et al.), 1997. "Antitumor Agents. 172. Synthesis and Biological Evaluation of Novel Deacetamidothiocolchicin-7-ols and Ester Analogs as Antiubulin Agents"	1 ~ 4
A	Journal of Medicinal Chemistry, 33(2), pp.567-571, (Anjum, Muzaffar et al.), 1990. "Antitubulin Effects of Derivatives of 3-Demethylthiocolchicine, Methylthio Ethers of Natural Colchicinoids, and Thioketones Derived from Thiocolchicine"	1 ~ 4
A	Journal of Medicinal Chemistry, 28(9), pp.1204-1208, (Kerkes, Peter et al.), 1985. "Synthesis and biological effects of novel thiocolchicines. 3. evaluation of N-Acyldeacetylthiocolchicines, N-(alkoxycarbonyl)deacetylthiocolchicines, and O-ethyldeacetylthiocolchicines. New synthesis of thiodemecolcine and antileukemic effects of 2-demethyl- and 3-demethylthiocolchicine"	1 ~ 4

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family


Date of the actual completion of the international search

16 SEPTEMBER 2002 (16.09.2002)

Date of mailing of the international search report

16 SEPTEMBER 2002 (16.09.2002)

Name and mailing address of the ISA/KR



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